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**Reservoir Fluid Study**

**Field: Kaybob**

**Formation: Duvernay**

**Well: ECA Hz Wahigan**

**04-12-064-23W5**

**CL-70073**

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## SUMMARY

### Study Objective

Encana Corporation commissioned Weatherford Laboratories - Calgary to perform a PVT study using multi-rate separator samples collected from well ECA Hz 04-12-064-23W5 of the Kaybob field, Duvernay formation. The study aims to provide characterization of the fluid in situ and to measure the current physical and compositional properties associated with the fluid.

### Technical Approach

The reservoir fluid study was conducted on a representative reservoir fluid in situ obtained following the Weatherford Oil System Characterization Protocol. Constant Composition Expansion at different temperatures, Differential Liberation at reservoir temperature and Multi-stage separator tests were performed on the fluid simulating the reservoir depletion process.

### Analyses Summary

The following analyses summary is provided to enhance understanding of the laboratory data and to offer additional insight relative to Weatherford's experience with laboratory and field processes. They represent our interpretation as to possible mechanisms and physical phenomena that may be occurring within the laboratory models that have been studied. These laboratory experiments are microscale representations of the field scenario; however macroscale phenomena may override behaviour exhibited in the laboratory. A more thorough development of the conclusions is presented in the Discussion section of the report.

Multirate sampling was conducted to assess the changes in fluid properties as the flowing bottomhole pressure varies with flowrates. Four sampling rates were collected and delivered to the laboratory. The details of the samples are summarized below.

Rate #	Gas Rate, e3m3/day	Production GOR, m3/m3	Meter Temperature, °C	Static Pressure, kPa
1	48	211	46	5654
2	74	217	58	5654
3	98	249	60	5309
4	114	279	65	5792

Upon review of the production gas-oil ratios, rate 1 samples were selected to be the most representative separator gas and liquid samples for physical recombination. The physical recombination was conducted at the agreed production gas-liquid ratio =  $211 \text{ m}^3/\text{m}^3$ .

The recombined fluid exhibited a bubble point pressure of 25.67 MPa at a reservoir temperature of  $109.8^\circ\text{C}$ , lower than the reservoir pressure (56.82 MPa). This saturation pressure indicates an under-saturated oil reservoir (bubble point system). Based on these assessments, the fluid characterization was completed according to Weatherford Oil System Characterization protocol. A comprehensive oil PVT study was conducted on the recombined fluid; including constant composition expansion at different temperatures, differential liberation at reservoir temperature and multi-stage separator tests.

The salient conclusions and recommendations of the study are:

1. On the basis of detailed compositional analysis, constant composition expansion, differential liberation and multi-stage separator tests, sufficient data were provided to effectively characterize the vapor-liquid phase behavior of ECA Hz 04-12-064-23W5 reservoir fluid from a primary depletion perspective.
2. The Weatherford Oil System Characterization protocol determined that the reservoir fluid is a bubble point system.
3. A constant composition expansion test measured a bubble point pressure = 25.67 MPa at the reservoir temperature of  $109.8^\circ\text{C}$ .
4. The differential liberation test measured the following fluid properties at saturation pressure: solution gas-oil ratio ( $R_s$ ) =  $507.17 \text{ m}^3/\text{m}^3$ , formation volume factor ( $B_o$ ) = 2.8942, reservoir oil density =  $501.6 \text{ Kg}/\text{m}^3$ , and reservoir oil viscosity = 0.1 mPa.s.
5. The residual oil from differential liberation exhibited 42.59 API gravity and 0.7 mPa.s viscosity.
6. The multi-stage separator test measured the following fluid properties at saturation pressure: solution gas-oil ratio ( $R_s$ ) =  $321.09 \text{ m}^3/\text{m}^3$  and formation volume factor ( $B_o$ ) = 2.1783. The stock tank oil from the multi-stage separator test exhibited 48.9 API gravity.
7. The constant composition expansion tests measured bubble point pressures of 23.45, 25.67, 26.64, and 25.62 MPa at temperatures of 80, 109.8, 160 and  $210^\circ\text{C}$  respectively.

## RESULTS & DISCUSSION

Encana Corporation commissioned Weatherford Laboratories - Calgary to perform a PVT study using multi-rate separator samples collected from well ECA Hz 04-12-064-23W5 of the Kaybob field, Duvernay formation. Multi-rate sampling was performed and separator gas and liquid samples from four sampling rates were collected and delivered to the laboratory. Sample validations were conducted. Upon review of the production gas-oil ratios, rate 1 samples were selected to be the most representative separator gas and liquid samples for physical recombination. The physical recombination was conducted at a production gas-liquid ratio = 211 m<sup>3</sup>/m<sup>3</sup>. The results of the selected sample validations are included in Appendix F.

The resulting recombined fluid exhibited a bubble point pressure of 25.67 MPa at a reservoir temperature of 109.8°C, lower than the reservoir pressure (56.82 MPa). This saturation pressure indicates an under-saturated oil reservoir (bubble point system). The composition of the recombined fluid was determined by performing a single stage flash measuring the flash GOR and compositional analysis of the flash gas and liquid. These data are reported in Appendix A. Based on these assessments; the fluid characterization was completed according to Weatherford - Oil System characterization protocol (refer to Appendix G). A comprehensive oil PVT study was conducted on the recombined fluid.

Subsequently, constant composition expansion at different temperatures, differential liberation and multi-stage separator tests were conducted on the on the recombined fluid. The pertinent data are summarized below.

<b>INITIAL RESERVOIR CONDITIONS</b>		
Reservoir Pressure	8241 psia	56.82 MPa
Reservoir Temperature:	229.7 F	109.8 C

<b>CONSTANT COMPOSITION EXPANSION @ 229.7 F (109.8 C)</b>		
Saturation Pressure	3724 psia	25.67 MPa
Compressibility @ Reservoir Pressure	1.85077E-05 psia <sup>-1</sup>	2.684327E-03 MPa <sup>-1</sup>
Compressibility @ Saturation Pressure	4.54808E-05 psia <sup>-1</sup>	6.596448E-03 MPa <sup>-1</sup>



<b>DIFFERENTIAL LIBERATION @ 229.7 F (109.8 C)</b>		
At Saturation Pressure		
Oil Formation Volume Factor	2.8942 res.bbl/STB	2.8942 res.m <sup>3</sup> /m <sup>3</sup>
Solution Gas-Oil Ratio	2847.67 scf/STB	507.17 m <sup>3</sup> /m <sup>3</sup>
Oil Density	0.5016 g/cm <sup>3</sup>	501.6 kg/m <sup>3</sup>
Oil Viscosity	0.083 cp	0.1 mPa.s
At Ambient Pressure		
Residual Oil Density	0.7471 g/cm <sup>3</sup>	747.1 kg/m <sup>3</sup>
Residual Oil Viscosity	0.749 cp	0.7 mPa.s
At Tank Conditions		
Residual Oil Density	0.8128 g/cm <sup>3</sup>	812.8 kg/m <sup>3</sup>
API Gravity	42.59	42.59

<b>MULTI-STAGE SEPARATOR TEST</b>		
Saturation Pressure	3724 psia	25.67 MPa
At Saturation Pressure		
Oil Formation Volume Factor	2.1783 res.bbl/STB	2.1783 res.m <sup>3</sup> /m <sup>3</sup>
Solution Gas-Oil Ratio	1802.83 scf/STB	321.09 m <sup>3</sup> /m <sup>3</sup>
Oil Density	0.5016 g/cm <sup>3</sup>	501.6 kg/m <sup>3</sup>
At Ambient Pressure		
Residual Oil Density	0.7843 g/cm <sup>3</sup>	784.3 kg/m <sup>3</sup>
At Tank Conditions		
Residual Oil Density	0.7843 g/cm <sup>3</sup>	784.3 kg/m <sup>3</sup>
API Gravity	48.9	48.9

<b>SINGLE-STAGE SEPARATOR TEST</b>		
At Saturation Pressure		
Oil Formation Volume Factor	2.3412 res.bbl/STB	2.3412 res.m <sup>3</sup> /m <sup>3</sup>
Solution Gas-Oil Ratio	2038.59 scf/STB	363.07 m <sup>3</sup> /m <sup>3</sup>
At Tank Conditions		
Residual Oil Density	0.7922 g/cm <sup>3</sup>	792.2 kg/m <sup>3</sup>
API Gravity	47.1	47.1

The compositional analysis of reservoir fluid is given in Table 1.

The PVT cell was charged with separate portions of the fluid sample and a constant composition expansion (CCE), differential liberation (DL) and three-stage separator experiments were performed on the fluid.

Table 2 provides the CCE results of the average compressibility of the reservoir fluid at pressures above the saturation pressure. Table 3 contains the complete CCE results with the exception of the data already presented in Table 2. Figure 1 shows the relative total volume (V/V<sub>sat</sub>) data and Y-function.

Table 4 contains various property measurements made on the differentially liberated oil below the bubblepoint including live oil density, oil formation volume factor, and gas-oil ratios. These are shown in Figures 2 through 4, respectively.

Table 5 contains a summary of the properties of the differentially liberated gas including gas gravities, deviation factors, gas formation volume factors and gas expansion factors. The gas deviation factor ( $Z$ ), gas formation volume factor and gas expansion factor, and gas gravity are shown in Figures 6 through 8, respectively.

Table 6 provides the results of the reservoir fluid viscosity measurements. This data is represented by Figures 5 and 9. Gas phase viscosity was calculated using the compositional data and the Lee, Gonzalez, Eakin correlation.

Table 7 summarizes the effluent gas compositions from each pressure stage during the differential liberation experiments. Figure 10 shows this data plotted on semi-log co-ordinates. Table 8 presents the compositional analysis of the residual oil at completion of the experiment.

Appendix B contains the material balance check performed for the differential liberation experiment. It is displayed as formation volume factors so that the balance can be checked on a point by point basis. Appendix C contains the detailed compositional analyses of the liberated gases from the differential liberation test.

Table 9 contains various oil property measurements performed on the multi-stage separator test including live oil density, oil formation volume factor and gas-oil ratios.

Table 10 contains a summary of the gas properties including gas gravities, deviation factors, gas formation volume factors and gas expansion factors from the multi-stage separator test.

Table 11 presents the compositional analysis of the residual oil at completion of the multi-stage experiment.

Table 12 summarizes the differential liberation data adjusted to flash liberation separator conditions. These data is graphically presented in Figures 11 and 12.

Appendix D contains the material balance check performed for the multi-stage separator experiment. Appendix E contains the detailed compositional analyses of the liberated gases from the multi-stage separator test.

Additional constant composition expansion (CCE) test were conducted to assess the changes in saturation pressure with temperature. The CCE's were performed at 80, 109.8, 160 and 210 °C. Table 13 presents the measured saturation pressures at these temperatures. These saturation pressures are presented graphically in a P-T diagram in Figure 13.

Table 14 shows the CCE results of the average compressibility of the reservoir fluid at pressures above the saturation pressure at 80°C. Table 15 contains the complete CCE results at this temperature.

Table 16 shows the CCE results of the average compressibility of the reservoir fluid at pressures above the saturation pressure at 109.8°C. Table 17 contains the complete CCE results at this temperature.

Table 18 shows the CCE results of the average compressibility of the reservoir fluid at pressures above the saturation pressure at 160°C. Table 19 contains the complete CCE results at this temperature.

Table 20 shows the CCE results of the average compressibility of the reservoir fluid at pressures above the saturation pressure at 210°C. Table 21 contains the complete CCE results at this temperature.

A summary of relative volumes for the four CCE's are presented in Figure14. Figure 15 presents the relative liquid phase volumes below the saturation pressures. Figure 16 summarizes the fluid densities above the saturation pressure.

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## PROCEDURE AND EQUIPMENT

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### Fluids Preparation and Analysis Procedure

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The following is an example of typical procedures and equipment used for fluids preparation, analysis and testing. Additional or unique procedures are outlined in the “Results and Discussion” section.

Separator oil properties were measured on duplicate samples to verify the quality of the samples. Two samples had a single stage flash performed at 60°C. Both samples were then subjected to compositional analysis to compare the samples and also to possibly detect sample contamination by extraneous hydrocarbon fluids.

Duplicate separator gas samples were analyzed for composition at 60°C. Any discrepancy between the two analyses may indicate that some components in the samples have condensed to liquid and that the samples must be thoroughly heated before use to vaporize these components.

To recombine live oil from separator oil and separator gas, the gas was first condensed into a high-pressure cylinder for high-pressure applications. By immersing the target high-pressure cylinder in liquid nitrogen, the low pressure gas could be readily transferred. The amount of pressure drop ( $\Delta P$ ) is calculated in terms of the amount of live oil ( $V_{oil}$ ) needed, the GOR of the oil, the live oil formation volume factor ( $B_o$ ), and the volume of the gas tank ( $V_{tank}$ ).

$$\Delta P = \frac{V_{oil}(cc) \times GOR(cc/cc)}{B_{oil} \times V_{tank}(cc)}$$

Once the specified pressure drop had been achieved on the source gas in the low pressure tank, the high pressure cylinder was then heated to system temperature. To increase the pressure to operating pressure, mercury was injected into the bottom of the cylinder which acted as a confining fluid. In this manner, any pressure can be obtained (up to 70 MPa) and a constant pressure injection can be maintained.

The oil supplied was from a separator sample. The required value of the separator sample ( $V_{sep}$ ) was calculated and added to the target cylinder. The live separator oil was pressured above the sampling pressure to ensure a single-phase fluid when transferring.

$$V_{sep} = \frac{V_{oil} \times B_{sep}}{B_{oil}} \text{ (cc)}$$

Once the gas and oil had been added together, the cylinder was isolated and thoroughly agitated at reservoir temperature to ensure a homogeneous fluid system.

The recombined sample was then pressurized to above the reservoir pressure and mixed into single phase. A single-stage flash gas-oil ratio (GOR) was measured by flashing a sample of the fluid from some pressure greater than the saturation pressure at reservoir temperature into an atmospheric separator and measuring the corresponding volumes of gas and liquid. This flash also provides parameters such as formation volume factor ( $B_o$ ) and live fluid density. Although these values are measured relative to the single phase fluid pressure from which they were flashed, the CCE provides data allowing these values to be corrected to the saturation pressure. These fluids (gas and liquid) were then subjected to compositional analysis using GC analysis, as mentioned in the "Equipment" section, from which a computer generated live oil composition was determined. Compositions of these gases and oils are determined in the following manner.

Mole fractions of gases are determined by injecting the gas of interest to an evacuated sample system while maintaining a slight negative pressure (7 cm Hg vacuum). The carrier gas (helium) transports the gas into the column, the thermal conductivity detector (TCD), flame ionizing detector (FID), and integrator indicate an area associated with each component. These areas are then translated into component mole fractions by the following formula:

$$\text{Mole Fraction}_{(1)} = \frac{\text{Area}_{(1)} \times \text{Calibration Constant}_{(1)}}{\sum_{i=1}^{N_{total}} \text{Area}_{(i)} \times \text{Calibration Constant}_{(i)}}$$

The subscript  $i$  in the expression represents the  $i$ th component in the gas and the calibration constant is an empirical amount per area ratio which relates the area detected to the mole fraction that should be present in the analytical standard. If the resulting mole fractions deviate from the standard, new calibration constants are calculated knowing the mole fraction and the area detected. Thus recalibration is easy to perform and can be checked daily by running a standard sample. Recalibration is usually only necessary biweekly at most and often only monthly. When recalibrated the differences are only very slight and often affect only the non-hydrocarbons.

Mole fractions in the flashed liquid sample are determined by injecting the liquid sample into the megabore column of the HP5890 GC. Calibration is made on a component basis. However, there are many more components than with the gas, a total of 47 including the unsaturated cyclics and aromatics enumerated in the "Description of the Equipment". Calibration of this column is carried out using a quantitative standard containing C6 through C40. The main deficiency of this analytical method is related to the fraction that does not elute from the column.

Some components, especially the heavier end of an oil sample, leave some residual amount behind in the column. This non-eluted portion, if uncorrected, will indicate a smaller fraction of these components than is actually present. In order to account for any hydrocarbon that is not eluted at the final temperature, the oil analyses are corrected based on a stabilized molecular weight ( $C_{6+}$ ) measured by cryoscope and a "non-elution" trial. The non-elution trial uses a GC run identical to the original oil analysis except that the liquid sample has had a measured quantity of 1-hexene added. The 1-hexene is designed to completely, or nearly completely, elute the oil sample in the GC column. Also, 1-hexene is used as the elution agent because it does not normally appear naturally in reservoir fluids thus allowing for its quick and easy identification amongst the naturally occurring oil components. After the 1-hexene eluted duplicate run has been performed the amount of original oil sample not eluted can be determined. Thus the fraction of the oil not eluted can be quantified and a correction applied to the compositional analysis. This appears in the form of a  $C_{30+}$  correction. Not only does this factor correct for the fraction of  $C_{30+}$  in the oil sample but also accounts for the fraction not eluted amongst any of the components lighter than  $C_{30+}$ .

Previous studies done by Hycal Energy Research Laboratories Ltd. (currently Weatherford) found that using a common  $C_{30+}$  mass fraction and molecular weight correction is

adequate for the majority of compositions of the same oil. For those few compositions that have undergone considerable mass transfer, this correction may be insufficient, but the error is attenuated since the corresponding gas analysis is unaffected and the GOR's for these samples are usually high.

## **Differential Liberation**

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The Differential Liberation experiment consists of two major portions: the constant composition expansion (CCE) and the actual differential liberation test (DL).

In the CCE experiment, a sample of the reservoir fluid is transferred to the PVT cell at a pressure of approximately 7000 kPa greater than the bubble point pressure. Starting at this pressure, the pressure in the cell is incrementally reduced by expanding the volume of the sample chamber, allowing time at each stage for equilibration. Gauge pressure, pump volume and gas/liquid/Hg interfaces are recorded at each stage.

The CCE test provides several pieces of information, the most important of which is the saturation pressure (bubble point) of the reservoir fluid. Secondly, it provides P-V relation data for the reservoir fluid such as relative volume and compressibility above and below the bubble point. It also allows the calculation of the Y-Function which, as indicated previously, is used as a data quality check. Since the two phase relative volume at pressures below the bubble point is generally a linear function of pressure, the Y-Function should also be linear. Subsequent to the CCE, the reservoir fluid is again pressured into single phase. Then the fluid is subjected to the following DL procedure:

1. The cell pressure is lowered to approximately 140 kPa greater than the bubble point. The volume of fluid in the PVT cell at this pressure is recorded.
2. The pressure in the PVT cell is lowered to the first designated pressure stage. Liquid and vapour phase volumes are measured using a cathetometer.
3. Keeping a constant pressure, liberated gas from the oil is displaced from the visual cell. The composition and volume of the displaced fluid are recorded.
4. Steps 2 and 3 are repeated for each designated pressure stage.

This procedure simulates the depletion of a typical oil reservoir during production.

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## Separator Test

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The separator test is conducted by the following procedure:

1. Starting at the reservoir temperature, the cell pressure is lowered to approximately 140 kPa greater than the bubble point. The volume of fluid in the PVT cell at this pressure is recorded.
2. The temperature of the PVT cell is lowered to the first stage separator temperature at constant pressure. Upon achieving a stable temperature, the pressure of the fluid is reduced to the first stage separator pressure and allowed to stabilize. Liquid and vapor phase volumes are measured using a cathetometer.
3. Keeping a constant pressure, liberated gas from the oil is displaced from the visual cell. The composition and volume of the displaced fluid are recorded.
4. Steps 2 and 3 are repeated for each designated separator stages until the stock tank stage.

This procedure simulates what happens in the near well bore & facilities.



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## **Description of Experimental Equipment**

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### **Fluid Recombination**

A cryogenic process is used to condense the sampled separator gas into a high pressure cylinder for the recombination of oil. High-pressure cylinders are used in the recombination procedure by condensing from the low pressure separator gas source to the high pressure gas source.

### **Compositional Analysis**

Analysis of the fluids and gases in this experiment is carried out on gas chromatographs (GC). Various techniques can be used to perform compositional analysis on hydrocarbon gases and liquids.

Analysis of light hydrocarbon fluids is conducted using an HP5890 liquid injection gas chromatograph equipped with flame ionization detector (FID) operated to a maximum temperature of 300°C. Separation of individual components is performed with a 30 meter, 530 micrometer diameter “Megabore” capillary column. It is a fused silica column using methyl silicone as the stationary phase. The stationary phase is 2.6 micrometers thick and is rated for operation in the temperature range of -60° to 300°C. Over this temperature range the components eluted are from C1 to C36 along with cyclopentane, methylcyclopentane, benzene, cyclohexane, methylcyclohexane, toluene, ortho-xylene, 1,2,4,-trimethylbenzene, meta- and para-xylene. That is, each of these components is retarded in its flow through the column, based on its physical properties, by the stationary phase. Thus the sample becomes segregated as it passes through the column. With prior knowledge of the amount of “retention” of a given compound, its relative magnitude can be determined by the length of time it remains in the column before it finally passing through. This is known as its retention time. For some compounds this can be lengthy so typically the temperature is gradually increased during the analysis to shorten retention times by a predefined amount.

The gas analyses are carried out on an HP5890 gas injection GC equipped with two separation columns. The first column is a combination of a 100 mesh packed column and a 100 mesh molecular sieve using high purity helium as a carrier gas. The molecular sieve is used to achieve separation of the very light gaseous components (N<sub>2</sub>, O<sub>2</sub>, C<sub>1</sub>), while the packed column

serves to separate ethane, propane, butanes, pentanes, and hexanes plus along with CO<sub>2</sub> and H<sub>2</sub>S. The second column is a capillary column as described previously in liquid analysis. This column is capable of achieving separation of components up to C<sub>12+</sub>, along with the associated naphthenes and aromatics, though these values are typically lumped into the C<sub>6+</sub> fraction during analysis. Components up to C<sub>4</sub> are analyzed using a thermal conductivity detector (TCD) while the C<sub>5+</sub> components are analyzed using an FID. The instrument has programmable air actuated multiport valves that let the flow of the sample mixture to be varied between the two columns allowing for the correct separation and analysis of the injected sample gas.

### **Differential Liberation & Separator Test Apparatus**

A PVT cell is used to measure the bubble point by the breakpoint of the PV curve resulting from the measure depletion of pressure from some pressure greater than the bubble point (single phase) to well below (the two-phase region). It consists of a PVT cell, source cylinders, capillary tube, collection cylinder, oven, buffers and pumps. The PVT cell is the heart of the apparatus where the fluids of interest are injected. The PVT cell has a rating of 70 MPa at about 200°C and has an internal volume of approximately 300 cm<sup>3</sup>. Connected to the PVT cell are high-pressure source cylinders containing fluids of interest. Displacing mercury into the bottom of the source cylinder with the pump transfers a corresponding volume into the visual cell. Thus, fluids can be transferred in prescribed volumes to within 0.02 cm<sup>3</sup>. The source cylinder is typically a 660 cm<sup>3</sup> 316 SS high-pressure cylinder rated to 70 MPa.

The oven in which this equipment is housed is capable of operation to 200°C and is controlled to ±0.5°C. The oven has been constructed so that it is capable of 180° rotation to expedite equilibration. With mercury used as the confining fluid in the visual cell, considerable mixing and agitation are provided when the oven is inverted.

The final equipment associated with the DL apparatus are the Ruska positive displacement pumps. They are capable of injecting at pressures up to 70 MPa. Digital Sensotec gauges were used in conjunction with the positive displacement pumps to set pressure levels; these gauges are accurate to ± 40 kPa.

**TABLE 1**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**COMPOSITIONAL ANALYSIS OF RESERVOIR FLUID**

Boiling Point (C)			Mole Fraction	Mass Fraction	Calculated Properties
-195.8	Nitrogen	N2	0.0095	0.0046	<b>Total Sample</b>
-78.5	Carbon Dioxide	CO2	0.0043	0.0033	
-60.3	Hydrogen Sulphide	H2S	0.0000	0.0000	Molecular Weight 57.16
-161.7	Methane	C1	0.4825	0.1355	
-88.9	Ethane	C2	0.1254	0.0659	
-42.2	Propane	C3	0.0822	0.0634	<b>C6+ Fraction</b>
-11.7	i-Butane	i-C4	0.0140	0.0143	
-0.6	n-Butane	n-C4	0.0356	0.0362	Molecular Weight 167.92
27.8	i-Pentane	i-C5	0.0129	0.0163	Mole Fraction 0.2181
36.1	n-Pentane	n-C5	0.0156	0.0197	Density (g/cc) 0.8200
36.1 - 68.9	Hexanes	C6	0.0244	0.0368	
68.9 - 98.3	Heptanes	C7	0.0223	0.0391	
98.3 - 125.6	Octanes	C8	0.0245	0.0490	<b>C7+ Fraction</b>
125.6 - 150.6	Nonanes	C9	0.0179	0.0402	
150.6 - 173.9	Decanes	C10	0.0136	0.0339	Molecular Weight 178.73
173.9 - 196.1	Undecanes	C11	0.0122	0.0313	Mole Fraction 0.1928
196.1 - 215	Dodecanes	C12	0.0097	0.0272	Density (g/cc) 0.8302
215 - 235	Tridecanes	C13	0.0095	0.0292	
235 - 252.2	Tetradecanes	C14	0.0079	0.0262	
252.2 - 270.6	Pentadecanes	C15	0.0058	0.0208	<b>C12+ Fraction</b>
270.6 - 287.8	Hexadecanes	C16	0.0047	0.0181	
287.8 - 291.7	Heptadecanes	C17	0.0040	0.0167	Molecular Weight 275.39
291.7 - 317.2	Octadecanes	C18	0.0039	0.0170	Mole Fraction 0.0754
317.2 - 330	Nonadecanes	C19	0.0034	0.0159	Density (g/cc) 0.8780
330 - 344.4	Eicosanes	C20	0.0028	0.0133	
344.4 - 357.2	Heneicosanes	C21	0.0024	0.0122	
357.2 - 369.4	Docosanes	C22	0.0021	0.0114	
369.4 - 380	Tricosanes	C23	0.0019	0.0106	
380 - 391.1	Tetracosanes	C24	0.0017	0.0097	
391.1 - 401.7	Pentacosanes	C25	0.0015	0.0092	
401.7 - 412.2	Hexacosanes	C26	0.0013	0.0084	
412.3 - 422.2	Heptacosanes	C27	0.0012	0.0076	
422.3 - 431.7	Octacosanes	C28	0.0011	0.0072	
431.7 - 441.1	Nonacosanes	C29	0.0009	0.0066	
Above 441.1	Tricontanes Plus	C30+	0.0097	0.0961	
48.9	Cyclopentane	C5H10	0.0009	0.0011	
72.2	Methylcyclopentane	C6H12	0.0039	0.0058	
81.1	Cyclohexane	C6H12	0.0033	0.0048	
101.1	Methylcyclohexane	C7H14	0.0088	0.0151	
80.0	Benzene	C6H6	0.0005	0.0007	
110.6	Toluene	C7H8	0.0022	0.0035	
136.1 - 138.9	Ethylbenzene & p,m-Xylene	C8H10	0.0025	0.0046	
144.4	o-Xylene	C8H10	0.0020	0.0037	
168.9	1, 2, 4-Trimethylbenzene	C9H12	0.0037	0.0078	
<b>Total</b>			<b>1.0000</b>	<b>1.0000</b>	

## **Constant Composition Expansion & Differential Liberation Tests**

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**TABLE 2**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**FLUID COMPRESSIBILITY @ 229.7 °F (109.8 °C)**

Pressure Range		Average Compressibility (psi <sup>-1</sup> )
From (psia)	To (psia)	
8513	7013	1.8508E-05
7013	5422	2.3697E-05
5422	4717	3.1725E-05
4717	4440	3.7331E-05
4440	4198	3.9808E-05
4198	3966	4.2474E-05
<b>3966</b>	<b>3724 Psat</b>	<b>4.5481E-05</b>

Pressure Range		Average Compressibility (MPa <sup>-1</sup> )
From (MPa)	To (MPa)	
58.69	48.35	2.6843E-03
48.35	37.38	3.4369E-03
37.38	32.52	4.6013E-03
32.52	30.61	5.4144E-03
30.61	28.94	5.7736E-03
28.94	27.34	6.1603E-03
<b>27.34</b>	<b>25.67 Psat</b>	<b>6.5964E-03</b>

Psat - Saturation Pressure

**TABLE 3**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**CONSTANT COMPOSITION EXPANSION @ 229.7 °F (109.8 °C)**

Pressure		Relative Volume [1]	Y-Function [2]	Fluid Density (g/cc)
(psia)	(MPa)			
8513	58.69	0.877877		0.5714
7013	48.35	0.902944		0.5555
5422	37.38	0.938320		0.5346
4717	32.52	0.959786		0.5226
4440	30.61	0.969815		0.5172
4198	28.94	0.979248		0.5122
3966	27.34	0.988994		0.5072
<b>3724 Psat</b>	<b>25.67</b>	<b>1.000000</b>		<b>0.5016</b>
3613	24.91	1.011973	2.5662	
3516	24.24	1.023443	2.5236	
3345	23.06	1.046274	2.4487	
3133	21.60	1.080080	2.3558	
2950	20.34	1.115309	2.2756	
2753	18.98	1.161124	2.1892	
2378	16.39	1.279566	2.0248	
2107	14.53	1.402676	1.9061	
1737	11.97	1.656051	1.7439	
1488	10.26	1.919361	1.6347	
1306	9.00	2.190878	1.5550	
1056	7.28	2.748359	1.4454	
887	6.11	3.332976	1.3713	
680	4.69	4.496823	1.2806	
553	3.81	5.683211	1.2249	

[1] Volume at indicated pressure per volume at saturation pressure  
 [2] Y Function = ((Psat-P)/P)/(Relative Volume - 1)  
 Psat - Saturation Pressure

**TABLE 4**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION OIL PROPERTIES @ 229.7°F (109.8°C)**

Pressure		Oil Density (g/cm <sup>3</sup> )	Oil Formation Volume Factor [1]	Total Formation Volume Factor [2]	Gas-Oil Ratio		Gas-Oil Ratio	
(psia)	(MPa)				Solution (scf/STB)	Liberated (scf/STB)	Solution (m <sup>3</sup> /m <sup>3</sup> )	Liberated (m <sup>3</sup> /m <sup>3</sup> )
8513	58.69	0.5714	2.5407	2.5407	2847.67	0.00	507.17	0.00
7013	48.35	0.5555	2.6133	2.6133	2847.67	0.00	507.17	0.00
5422	37.38	0.5346	2.7157	2.7157	2847.67	0.00	507.17	0.00
4717	32.52	0.5226	2.7778	2.7778	2847.67	0.00	507.17	0.00
4440	30.61	0.5172	2.8068	2.8068	2847.67	0.00	507.17	0.00
4198	28.94	0.5122	2.8341	2.8341	2847.67	0.00	507.17	0.00
3966	27.34	0.5072	2.8623	2.8623	2847.67	0.00	507.17	0.00
<b>3724 Psat</b>	<b>25.67</b>	<b>0.5016</b>	<b>2.8942</b>	<b>2.8942</b>	<b>2847.67</b>	<b>0.00</b>	<b>507.17</b>	<b>0.00</b>
3313	22.84	0.5333	2.5250	3.0511	2253.05	594.62	401.27	105.90
2913	20.08	0.5564	2.2746	3.2789	1835.27	1012.40	326.86	180.31
2513	17.33	0.5793	2.0801	3.5984	1516.50	1331.18	270.09	237.08
2113	14.57	0.6010	1.9298	4.0884	1266.39	1581.28	225.54	281.63
1813	12.50	0.6137	1.8585	4.6217	1125.05	1722.62	200.37	306.80
1413	9.74	0.6301	1.7608	5.7440	939.13	1908.54	167.26	339.91
1013	6.98	0.6447	1.6701	7.8924	759.57	2088.10	135.28	371.89
613	4.23	0.6592	1.5822	13.0128	581.18	2266.49	103.51	403.66
213	1.47	0.6877	1.4167	37.5653	359.66	2488.02	64.05	443.12
13	0.09	0.7471	1.0975	381.3465	0.00	2847.67	0.00	507.17

Density of Residual Oil = 0.8128 g/cm<sup>3</sup> (812.8 kg/m<sup>3</sup>) @ 60 F (288.7K)

[1] Barrels (Cubic meters) of oil at indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).

[2] Total barrels (cubic meters) of oil and liberated gas at the indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).

Psat - Saturation Pressure

- Tank conditions: 60 F (288.7 K) @ 13 psia (0.0896 MPa); Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa).

**TABLE 5**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION GAS PROPERTIES @ 229.7°F (109.8°C)**

Pressure		Gas Gravity		Gas Density (g/cm <sup>3</sup> )	Gas Deviation Factor (-)	Gas Formation Volume Factor [1]	Gas Expansion Factor [2]
(psia)	(MPa)	Incremental (Air = 1)	Cumulative (Air = 1)				
8513	58.69						
7013	48.35						
5422	37.38						
4717	32.52						
4440	30.61						
4198	28.94						
3966	27.34						
<b>3724 Psat</b>	<b>25.67</b>						
3313	22.84	0.8788	0.8788	0.2154	0.8472	0.0050	201.281
2913	20.08	0.8553	0.8691	0.1869	0.8355	0.0056	179.540
2513	17.33	0.8433	0.8629	0.1602	0.8293	0.0064	156.150
2113	14.57	0.8249	0.8569	0.1308	0.8354	0.0077	130.471
1813	12.50	0.8196	0.8538	0.1105	0.8431	0.0090	111.029
1413	9.74	0.8337	0.8519	0.0862	0.8566	0.0117	85.336
1013	6.98	0.8563	0.8523	0.0618	0.8799	0.0167	59.767
613	4.23	0.9241	0.8579	0.0391	0.9085	0.0283	35.314
213	1.47	1.1908	0.8876	0.0168	0.9441	0.0816	12.258
13	0.09	2.1686	1.0494	0.0018	0.9887	0.7497	1.334

[1] Cubic feet (meters) of gas at indicated pressure and temperature per cubic feet (meter) @ standard conditions

Psat - Saturation pressure  
- Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)



**TABLE 6**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION FLUID VISCOSITY @ 229.7°F (109.8°C)**

Pressure		Oil Viscosity (cp=mPa.s)	Gas Viscosity (cp=mPa.s)	Oil - Gas Viscosity Ratio
(psia)	(MPa)			
5413	37.32	0.088		
5013	34.56	0.086		
4513	31.12	0.084		
<b>3724 Psat</b>	<b>25.67</b>	<b>0.083</b>		
3313	22.84	0.093	0.02462	3.78
2913	20.08	0.117	0.02214	5.29
2513	17.32	0.139	0.02010	6.92
2113	14.57	0.174	0.01824	9.55
1813	12.50	0.197	0.01710	11.54
1413	9.74	0.238	0.01582	15.04
1013	6.98	0.283	0.01470	19.24
613	4.22	0.334	0.01363	24.51
213	1.47	0.451	0.01202	37.51
13	0.09	0.749	0.00925	81.01

Psat - Saturation Pressure

**TABLE 7**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**COMPOSITIONAL ANALYSIS OF LIBERATED GAS @ 229.7°F (109.8°C)**

Component	Differential Liberation Stage Pressure (psia/MPa)									
	3313	2913	2513	2113	1813	1413	1013	613	213	13
	22.84	20.08	17.33	14.57	12.50	9.74	6.98	4.23	1.47	0.09
N2	0.0152	0.0154	0.0153	0.0143	0.0129	0.0110	0.0087	0.0059	0.0022	0.0004
CO2	0.0045	0.0047	0.0050	0.0052	0.0055	0.0059	0.0064	0.0072	0.0075	0.0024
H2S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C1	0.6859	0.6952	0.7002	0.7064	0.7041	0.6894	0.6602	0.5893	0.3768	0.1309
C2	0.1361	0.1373	0.1380	0.1410	0.1454	0.1548	0.1714	0.2031	0.2471	0.1060
C3	0.0744	0.0714	0.0700	0.0697	0.0710	0.0756	0.0857	0.1103	0.1962	0.1653
i-C4	0.0116	0.0109	0.0106	0.0100	0.0101	0.0105	0.0117	0.0152	0.0300	0.0415
n-C4	0.0273	0.0255	0.0244	0.0229	0.0229	0.0237	0.0263	0.0339	0.0653	0.1172
i-C5	0.0078	0.0075	0.0070	0.0063	0.0062	0.0062	0.0067	0.0083	0.0178	0.0520
n-C5	0.0085	0.0084	0.0079	0.0069	0.0068	0.0068	0.0072	0.0088	0.0178	0.0629
C6	0.0095	0.0083	0.0079	0.0064	0.0063	0.0063	0.0064	0.0072	0.0152	0.0854
C7+	0.0193	0.0153	0.0136	0.0110	0.0088	0.0099	0.0093	0.0108	0.0240	0.2359
<b>Total</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>	<b>1.0000</b>

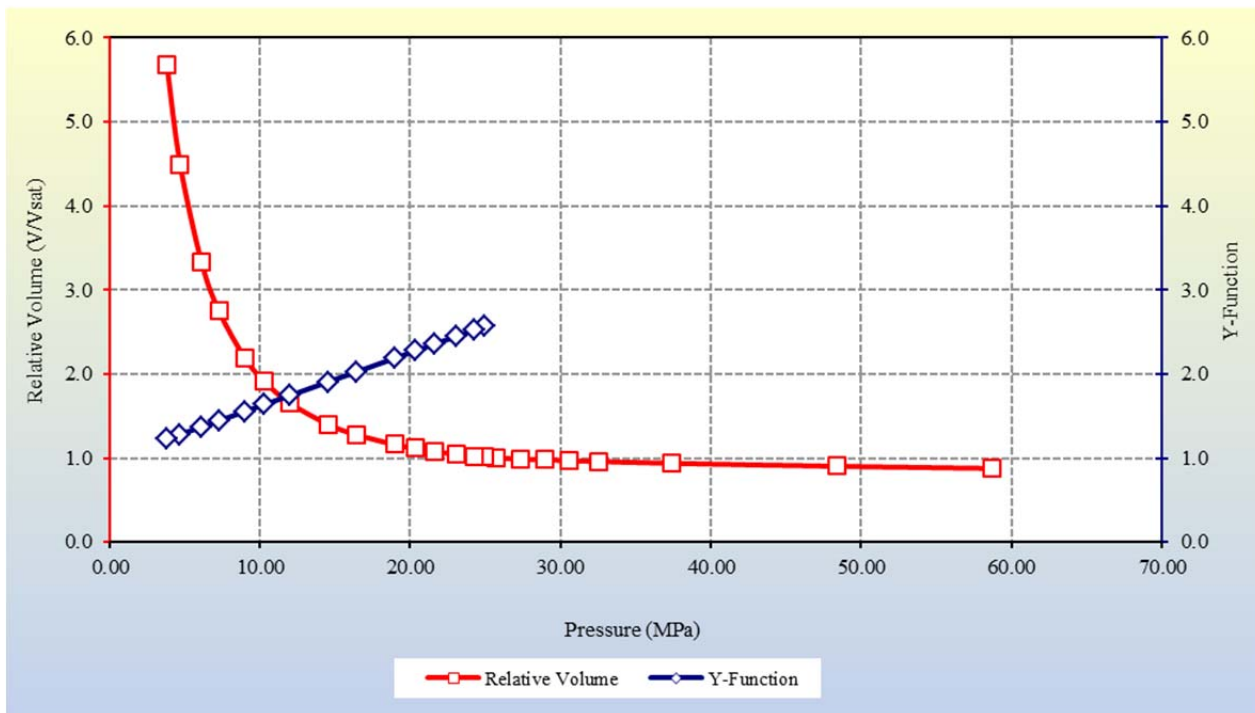
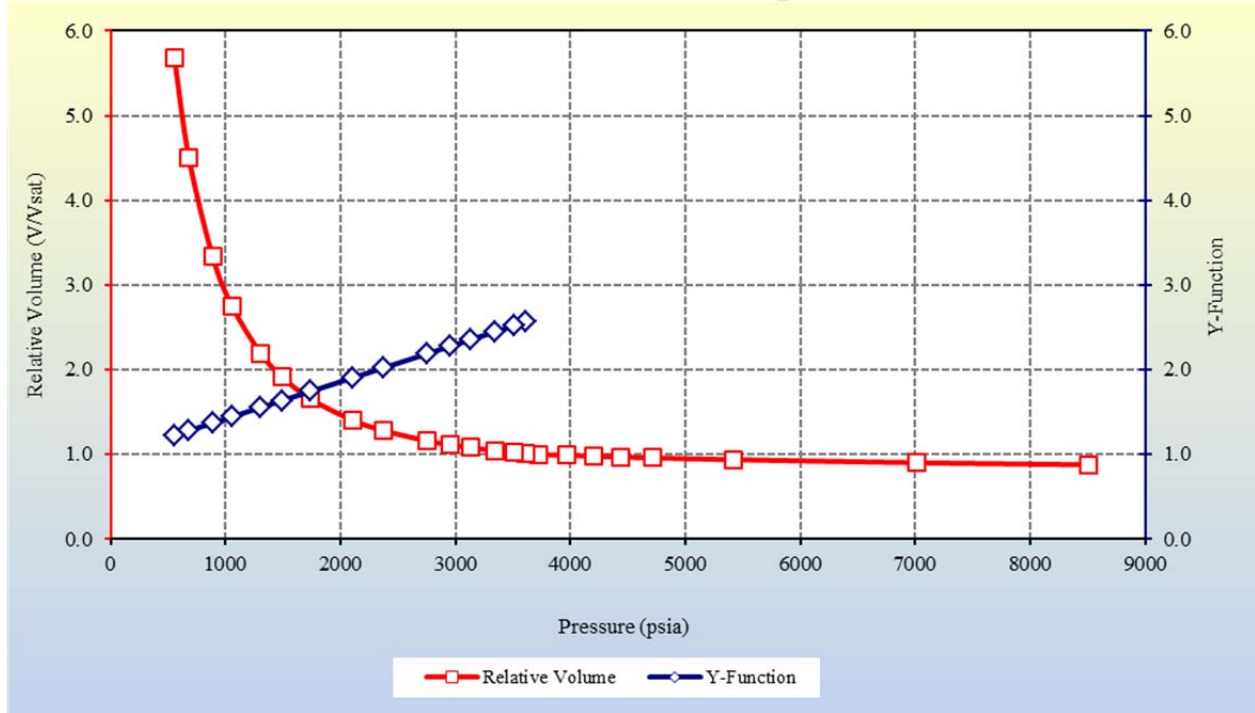
Calculated Properties of Total Sample @ Standard Conditions										
MW (g/mol)	25.45	24.77	24.42	23.89	23.74	24.15	24.80	26.77	34.49	62.81
Gravity (Air=1.0)	0.8788	0.8553	0.8433	0.8249	0.8196	0.8337	0.8563	0.9241	1.1908	2.1686

Calculated Properties of C7+ @ Standard Conditions										
MW (g/mol)	114.01	112.35	110.75	109.34	106.88	107.49	106.39	106.72	106.33	106.98
Density (g/cc)	0.7484	0.7467	0.7447	0.7432	0.7397	0.7408	0.7395	0.7402	0.7401	0.7411

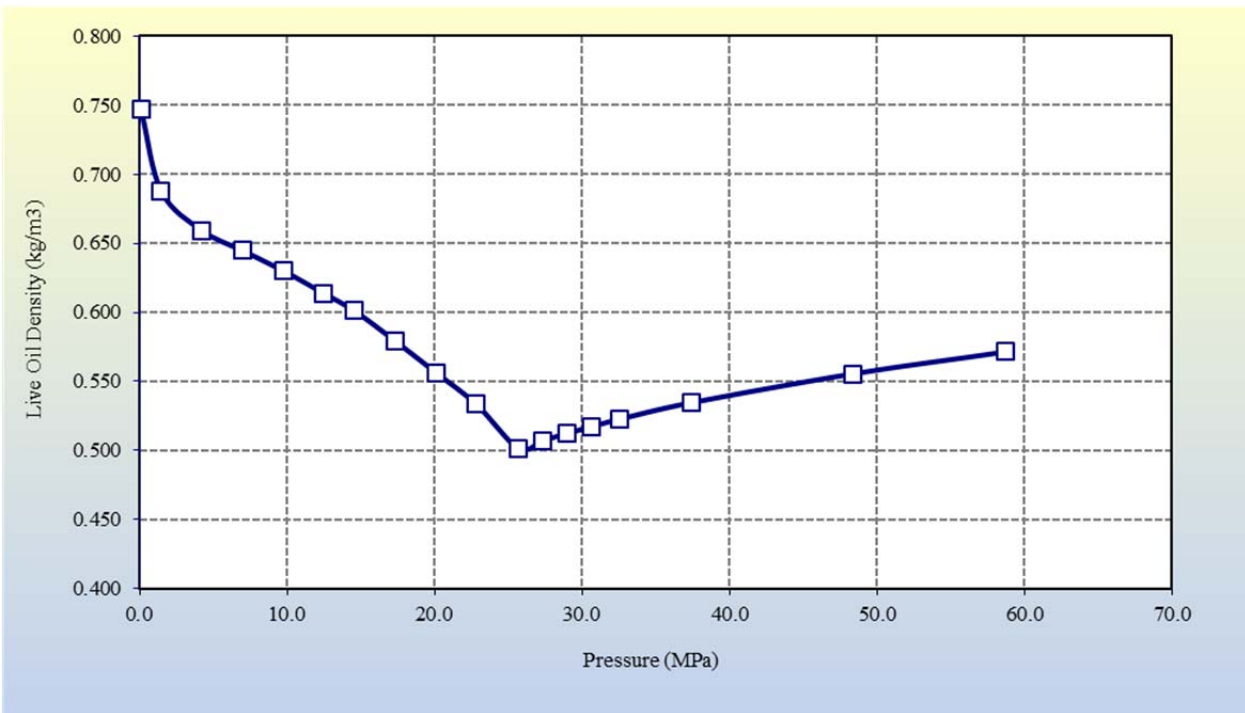
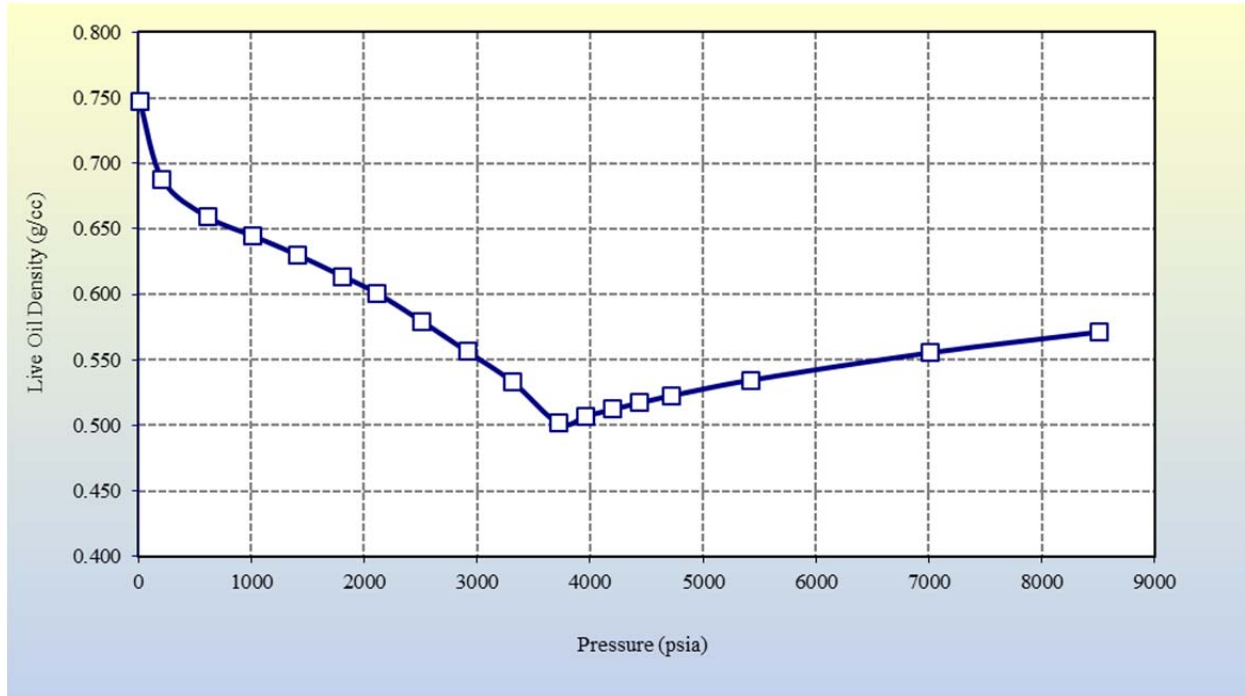
**TABLE 8  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF RESIDUAL OIL @ 229.7°F (109.8°C)**

Boiling Point (C)			Mole Fraction	Mass Fraction	Calculated Properties
-195.8	Nitrogen	N2	0.0000	0.0000	<b>Total Sample</b>
-78.5	Carbon Dioxide	CO2	0.0000	0.0000	
-60.3	Hydrogen Sulphide	H2S	0.0000	0.0000	Molecular Weight 179.43
-161.7	Methane	C1	0.0000	0.0000	
-88.9	Ethane	C2	0.0000	0.0000	
-42.2	Propane	C3	0.0012	0.0003	<b>C6+ Fraction</b>
-11.7	i-Butane	i-C4	0.0013	0.0004	
-0.6	n-Butane	n-C4	0.0068	0.0022	Molecular Weight 183.22
27.8	i-Pentane	i-C5	0.0091	0.0037	Mole Fraction 0.9672
36.1	n-Pentane	n-C5	0.0144	0.0058	Density (g/cc) 0.8308
36.1 - 68.9	Hexanes	C6	0.0494	0.0237	
68.9 - 98.3	Heptanes	C7	0.0716	0.0400	
98.3 - 125.6	Octanes	C8	0.1014	0.0645	<b>C7+ Fraction</b>
125.6 - 150.6	Nonanes	C9	0.0830	0.0594	
150.6 - 173.9	Decanes	C10	0.0691	0.0548	Molecular Weight 188.70
173.9 - 196.1	Undecanes	C11	0.0654	0.0535	Mole Fraction 0.9158
196.1 - 215	Dodecanes	C12	0.0514	0.0462	Density (g/cc) 0.8353
215 - 235	Tridecanes	C13	0.0540	0.0527	
235 - 252.2	Tetradecanes	C14	0.0441	0.0467	
252.2 - 270.6	Pentadecanes	C15	0.0348	0.0399	<b>C12+ Fraction</b>
270.6 - 287.8	Hexadecanes	C16	0.0275	0.0341	
287.8 - 291.7	Heptadecanes	C17	0.0230	0.0304	Molecular Weight 269.40
291.7 - 317.2	Octadecanes	C18	0.0226	0.0316	Mole Fraction 0.4216
317.2 - 330	Nonadecanes	C19	0.0203	0.0298	Density (g/cc) 0.8735
330 - 344.4	Eicosanes	C20	0.0160	0.0245	
344.4 - 357.2	Heneicosanes	C21	0.0146	0.0237	
357.2 - 369.4	Docosanes	C22	0.0122	0.0207	
369.4 - 380	Tricosanes	C23	0.0108	0.0191	
380 - 391.1	Tetracosanes	C24	0.0094	0.0174	
391.1 - 401.7	Pentacosanes	C25	0.0092	0.0177	
401.7 - 412.2	Hexacosanes	C26	0.0076	0.0151	
412.3 - 422.2	Heptacosanes	C27	0.0072	0.0151	
422.3 - 431.7	Octacosanes	C28	0.0066	0.0144	
431.7 - 441.1	Nonacosanes	C29	0.0053	0.0118	
Above 441.1	Tricontanes Plus	C30+	0.0449	0.1422	
48.9	Cyclopentane	C5H10	0.0020	0.0008	
72.2	Methylcyclopentane	C6H12	0.0109	0.0051	
81.1	Cyclohexane	C6H12	0.0104	0.0049	
101.1	Methylcyclohexane	C7H14	0.0320	0.0175	
80.0	Benzene	C6H6	0.0015	0.0006	
110.6	Toluene	C7H8	0.0084	0.0043	
136.1 - 138.9	Ethylbenzene & p,m-Xylene	C8H10	0.0120	0.0071	
144.4	o-Xylene	C8H10	0.0095	0.0056	
168.9	1, 2, 4-Trimethylbenzene	C9H12	0.0190	0.0127	
<b>Total</b>			<b>1.0000</b>	<b>1.0000</b>	

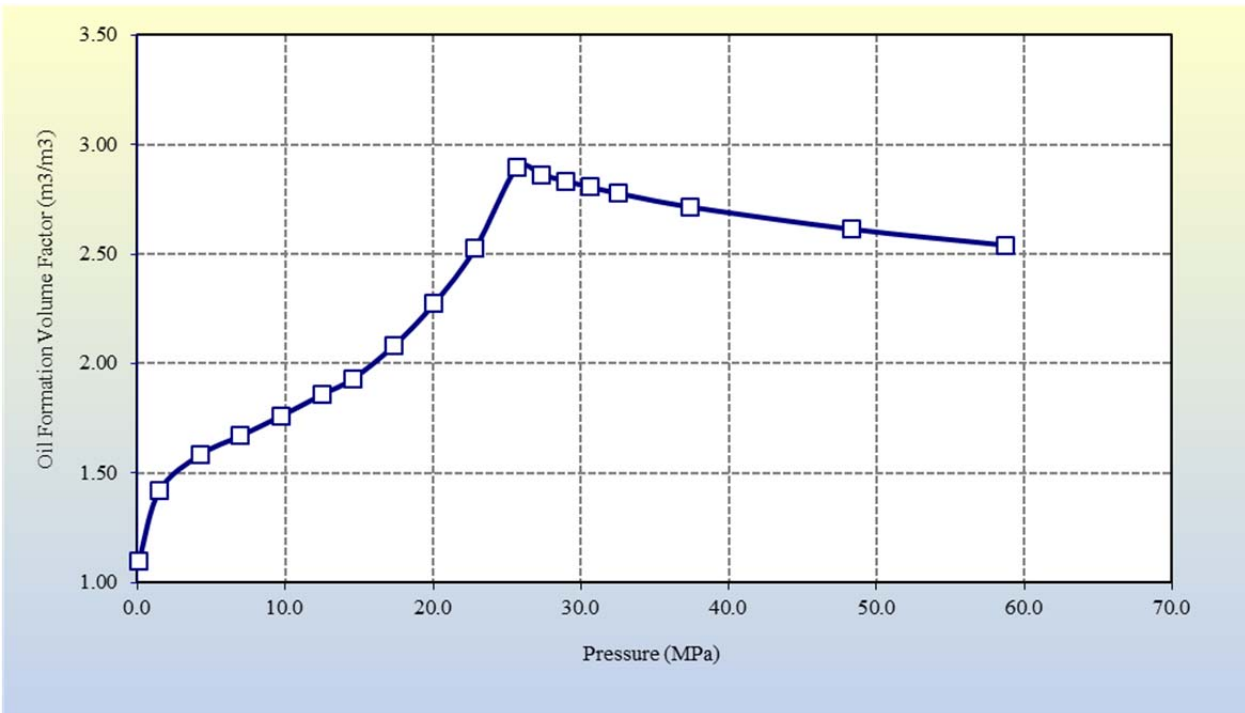
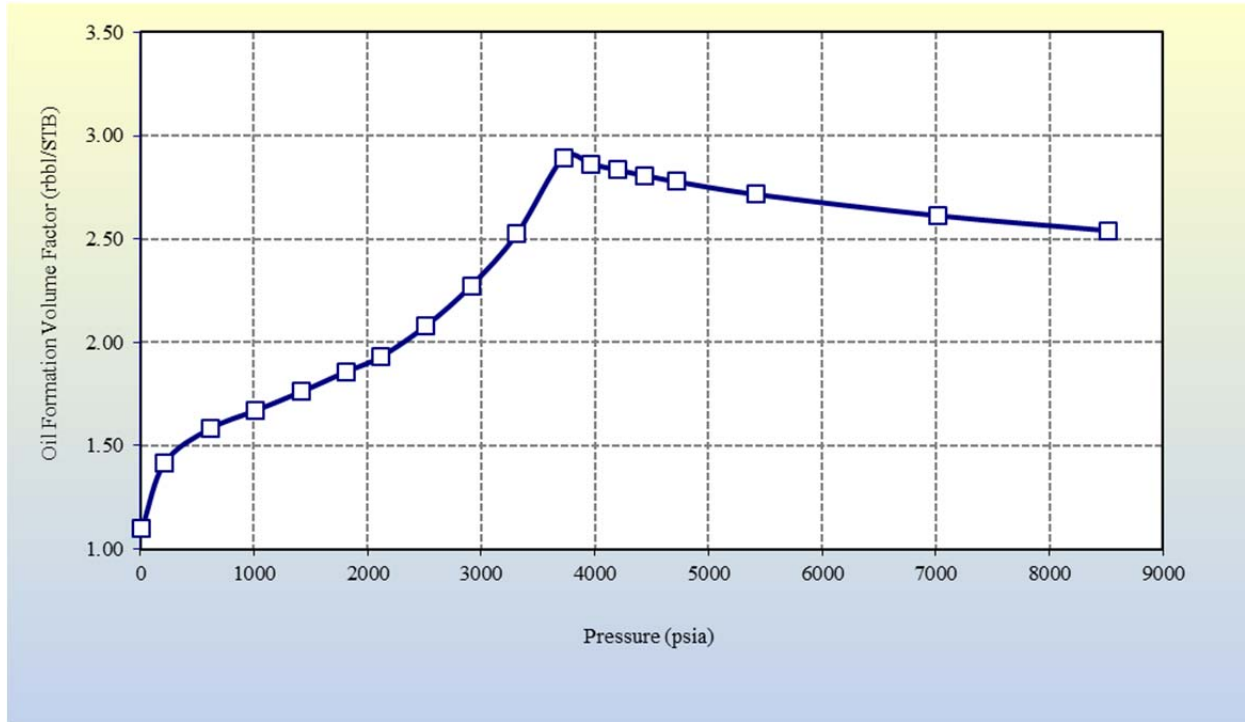
**FIGURE 1**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**CONSTANT COMPOSITION EXPANSION @ 229.7°F (109.8°C)**



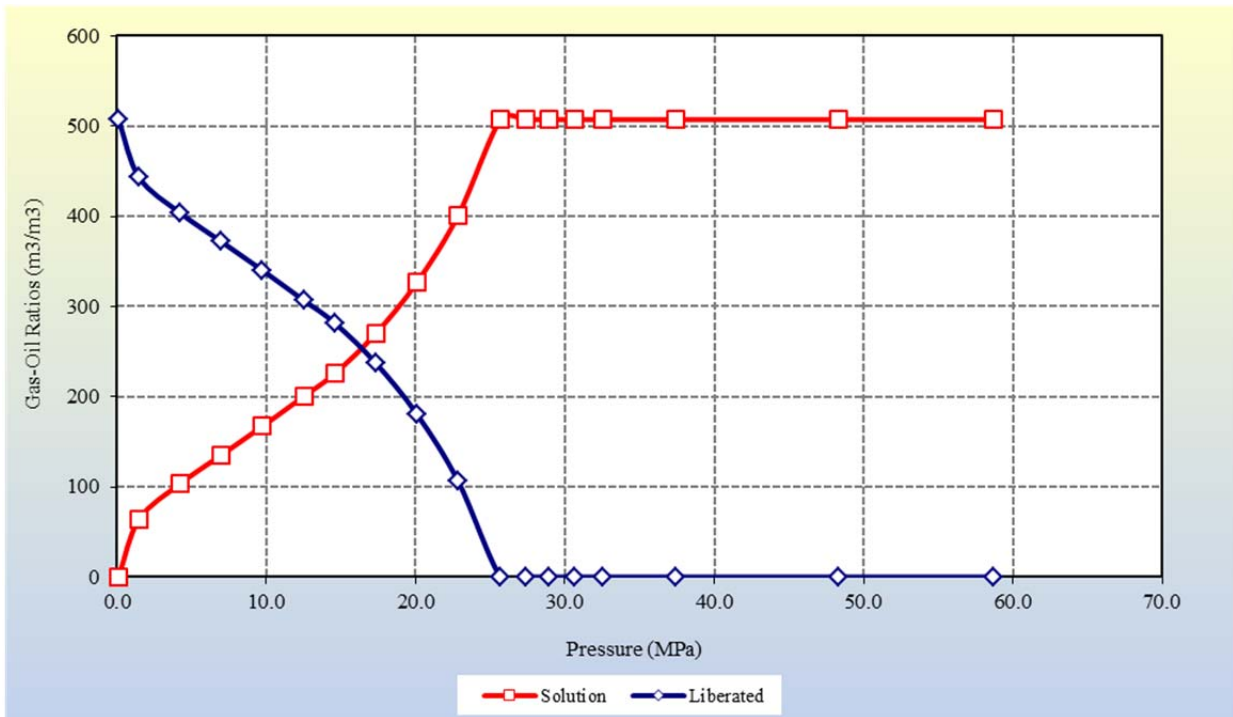
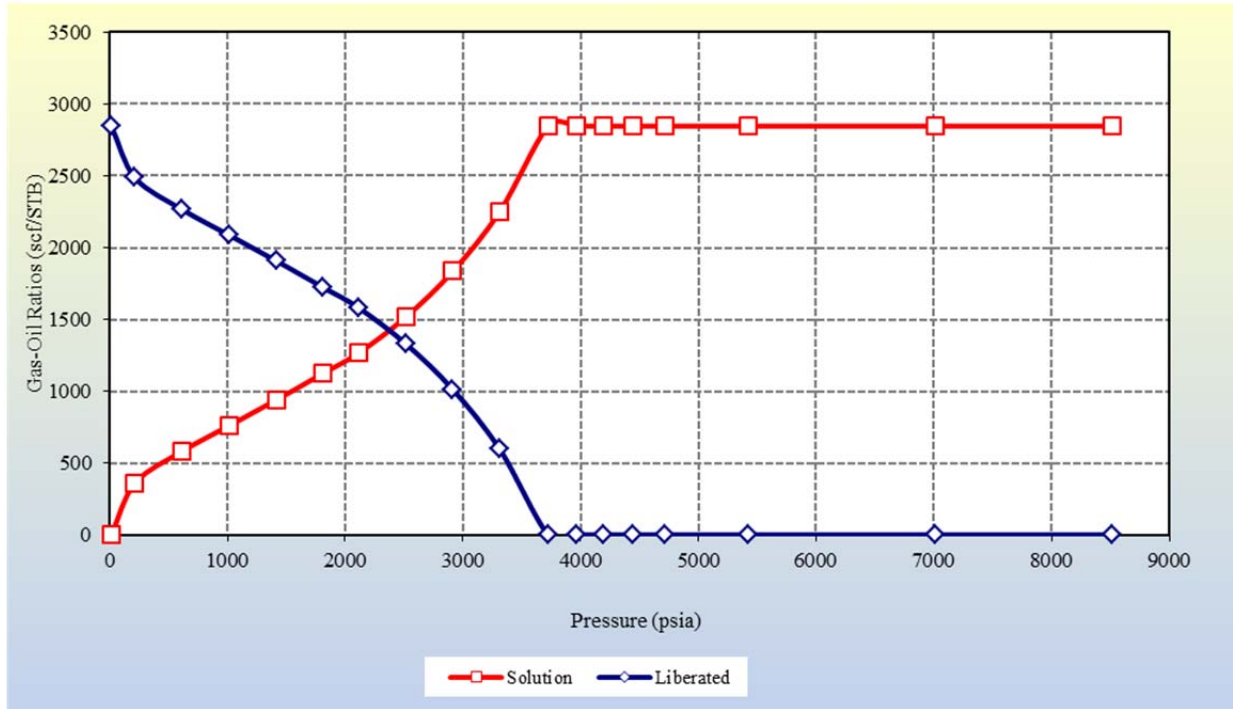
**FIGURE 2**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION OIL DENSITY @ 229.7°F (109.8°C)**



**FIGURE 3**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION OIL FORMATION VOLUME FACTOR @ 229.7°F (109.8°C)**

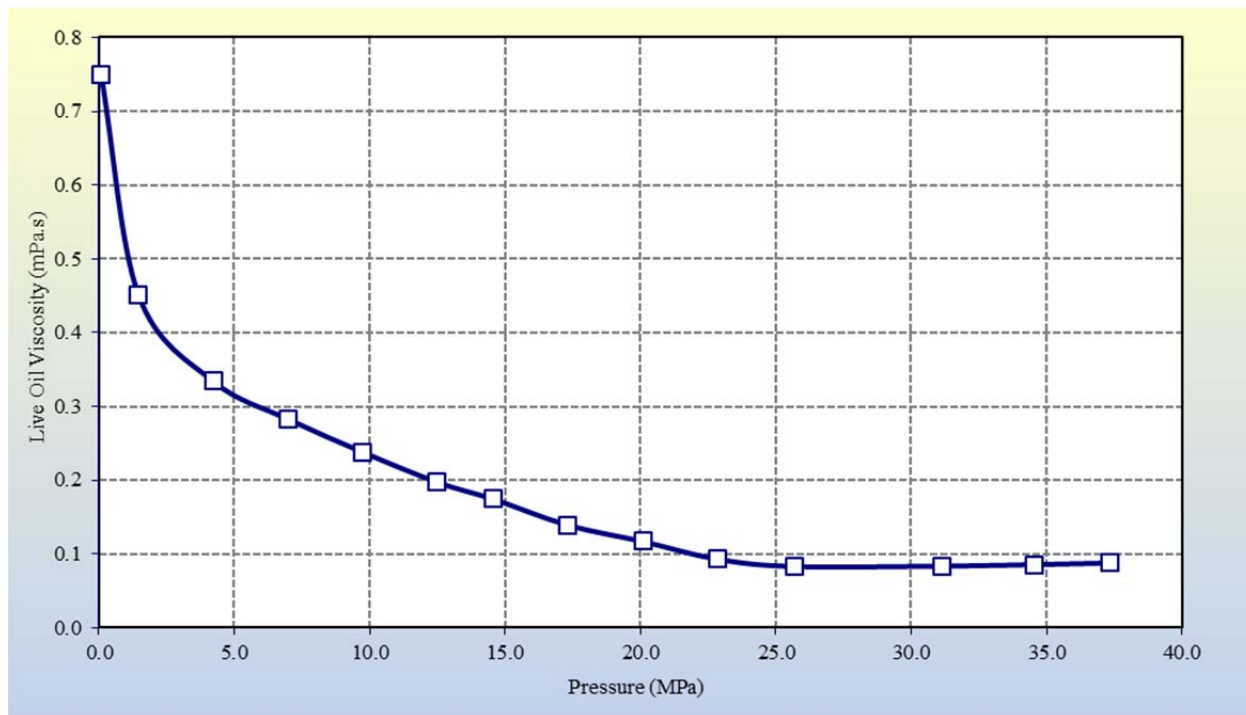
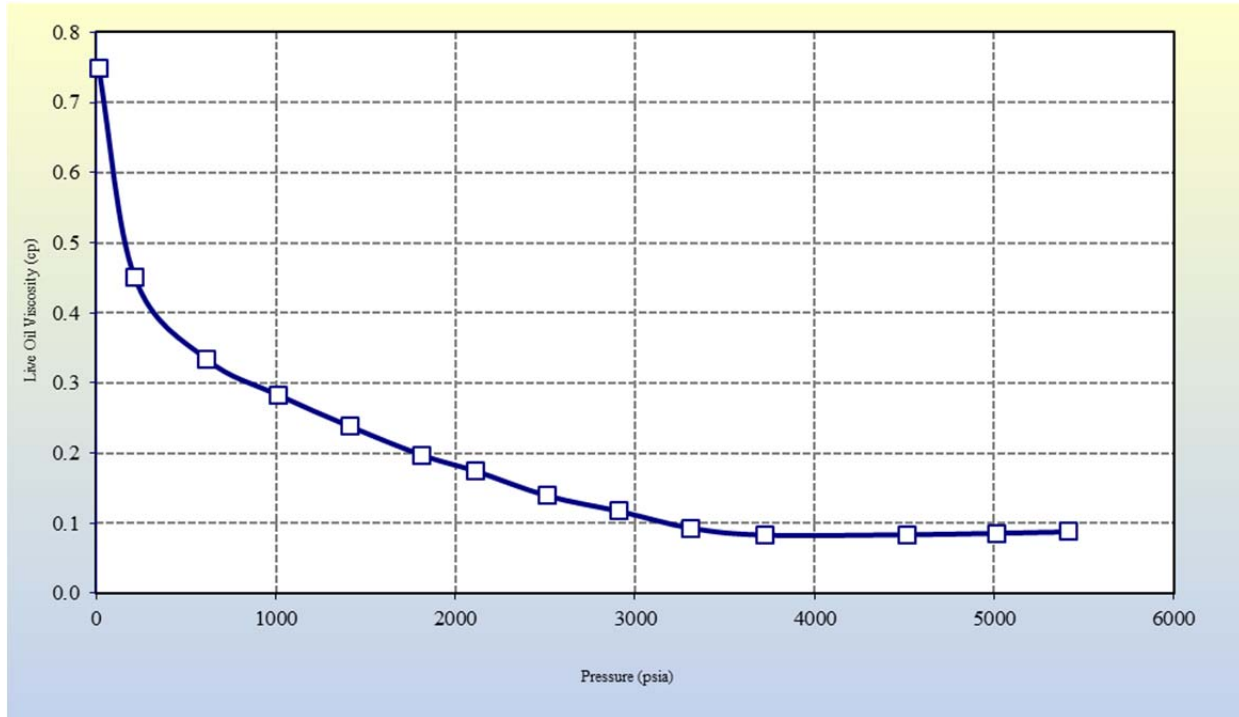


**FIGURE 4**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION GAS-OIL RATIOS @ 229.7°F (109.8°C)**



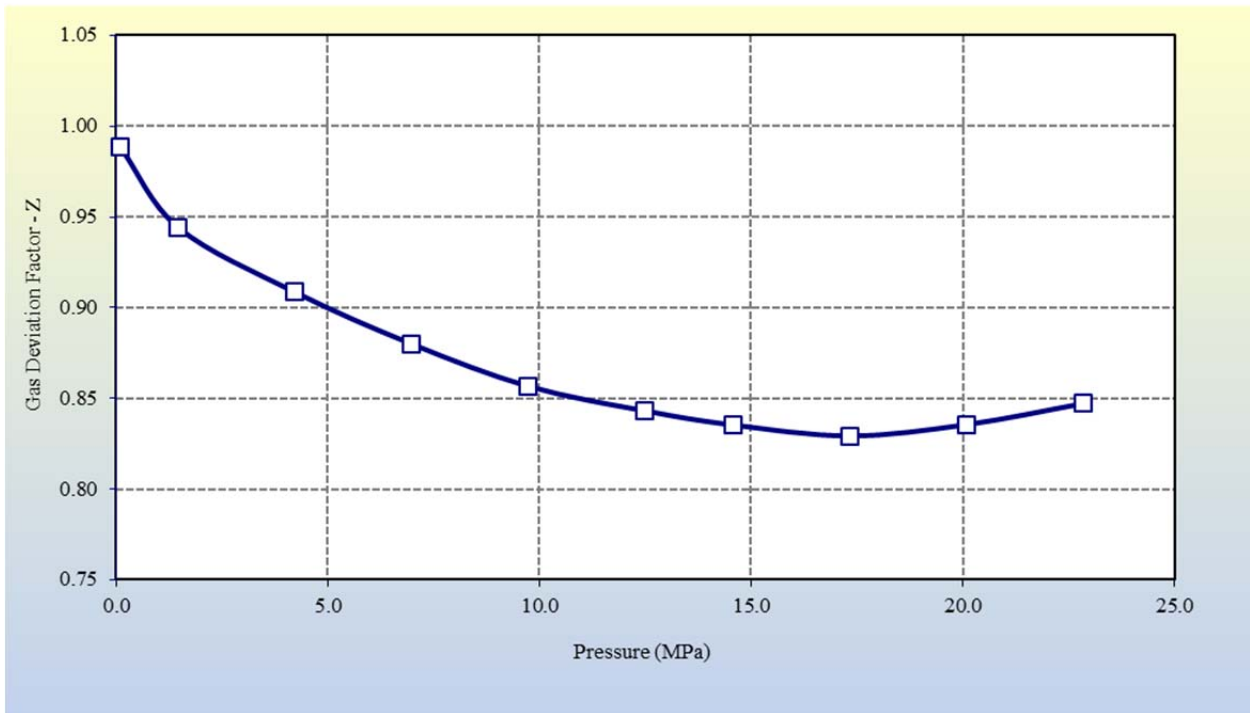
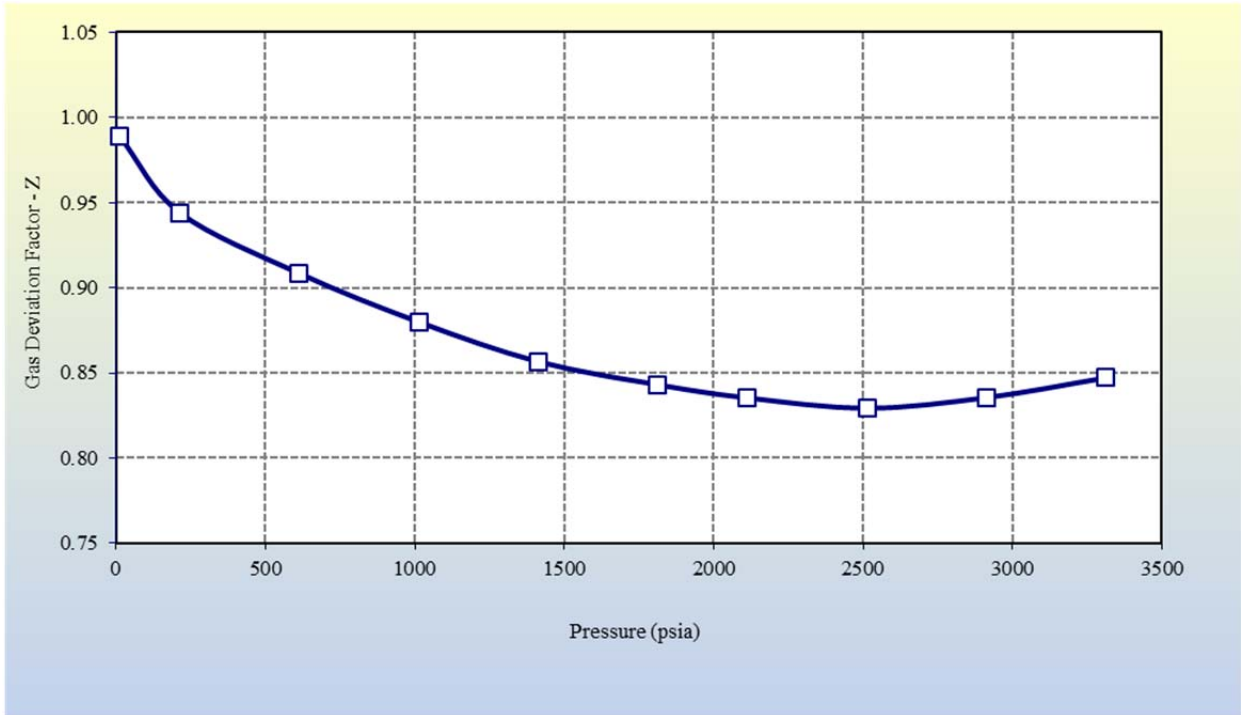


**FIGURE 5**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION OIL VISCOSITY @ 229.7°F (109.8°C)**

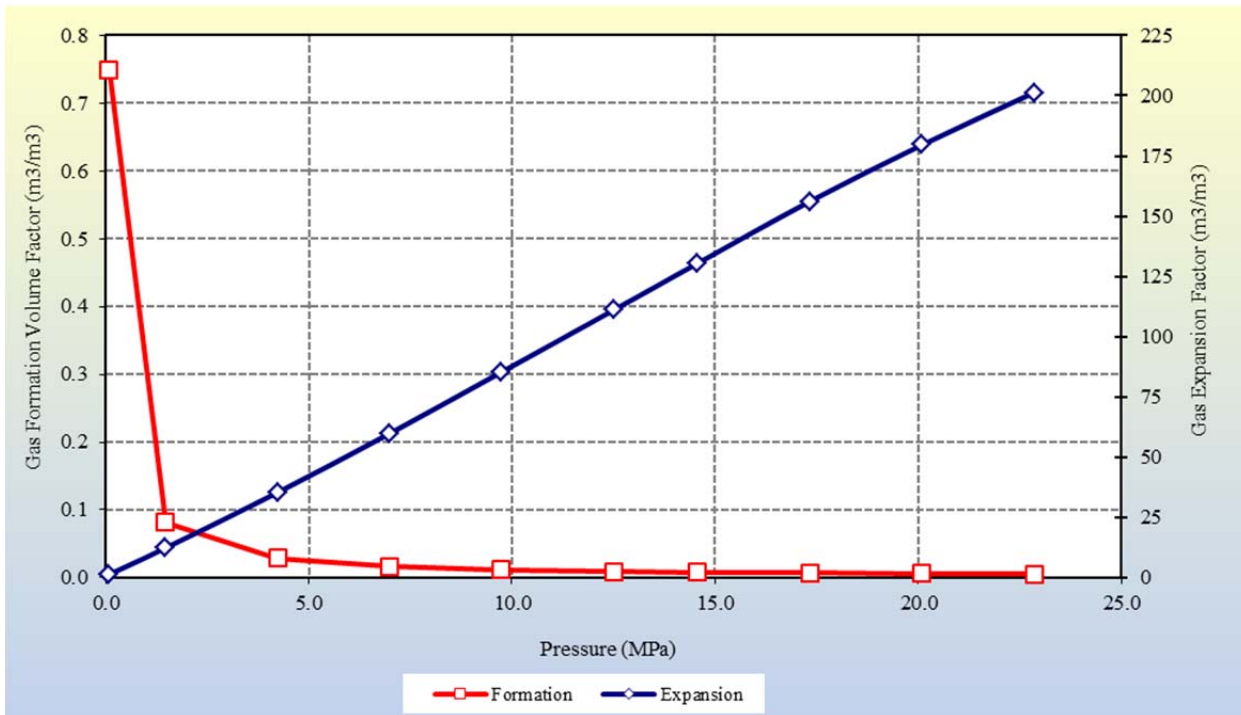
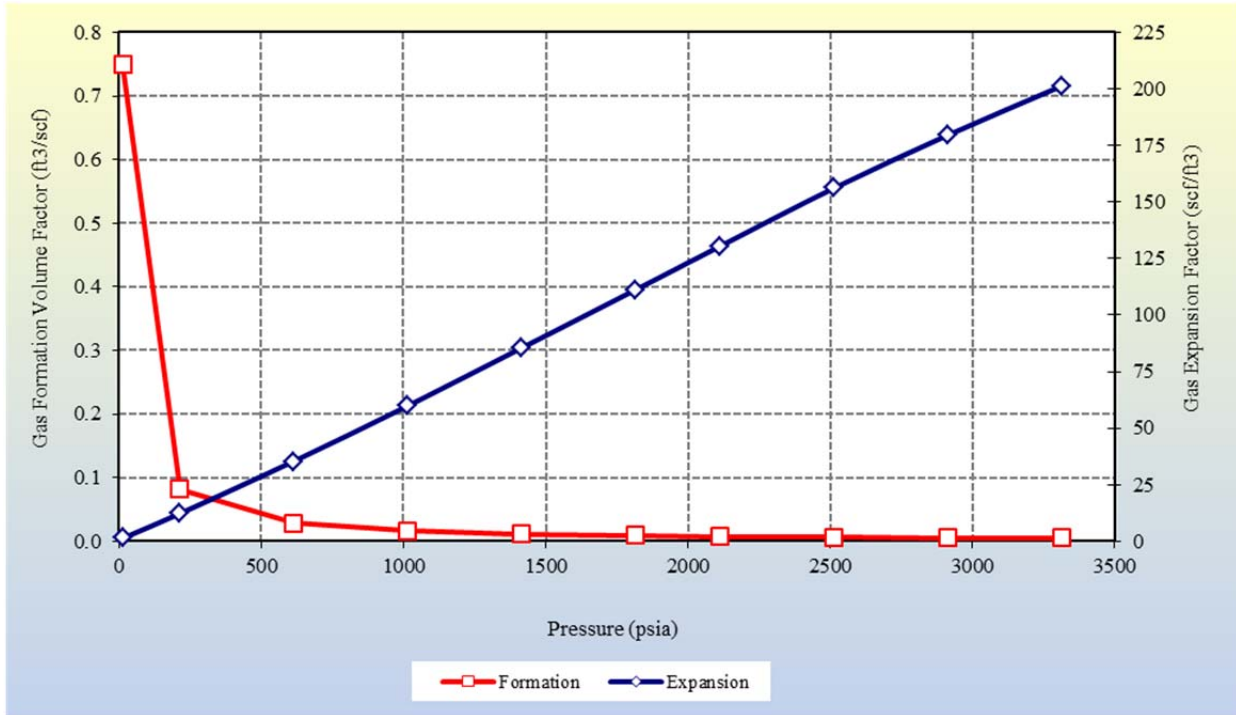




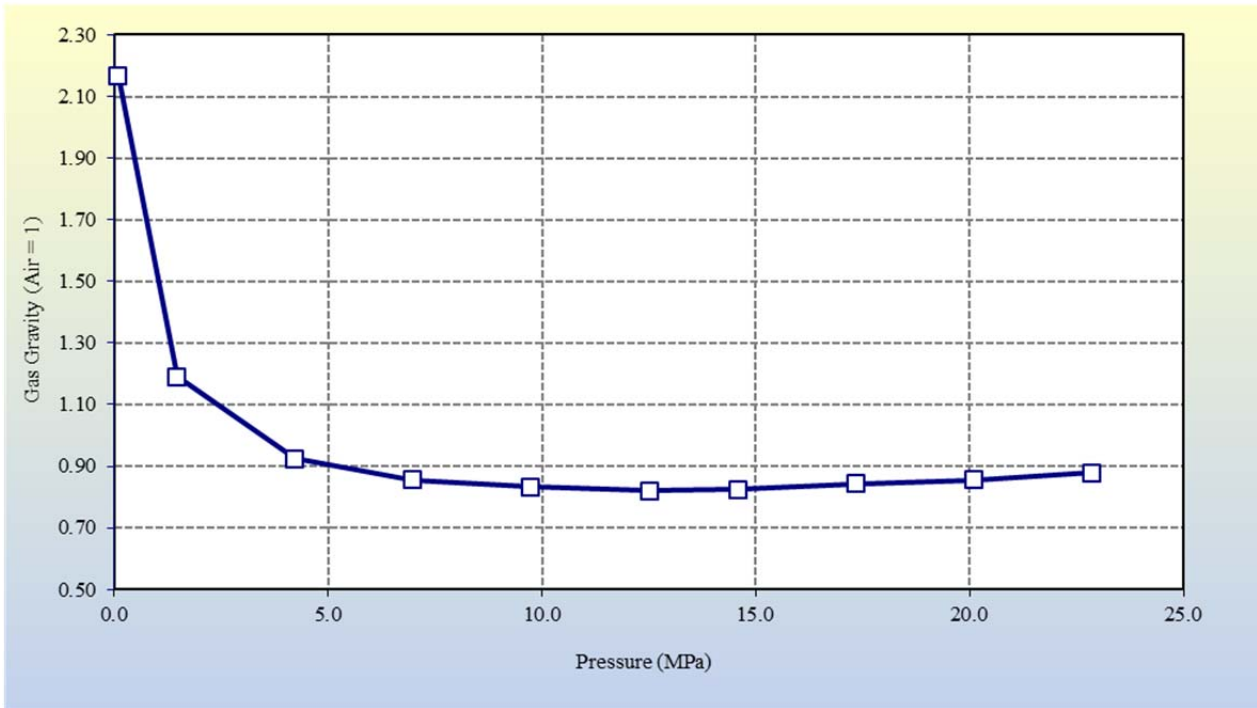
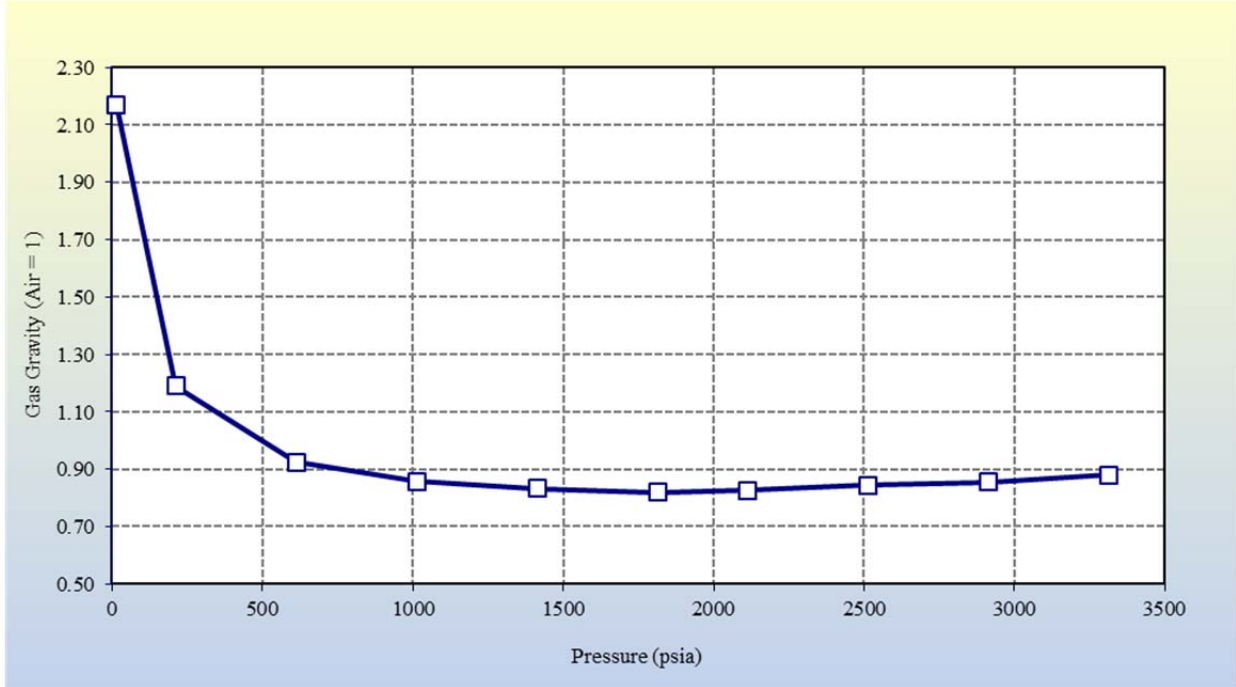
**FIGURE 6**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION GAS DEVIATION FACTOR @ 229.7°F (109.8°C)**



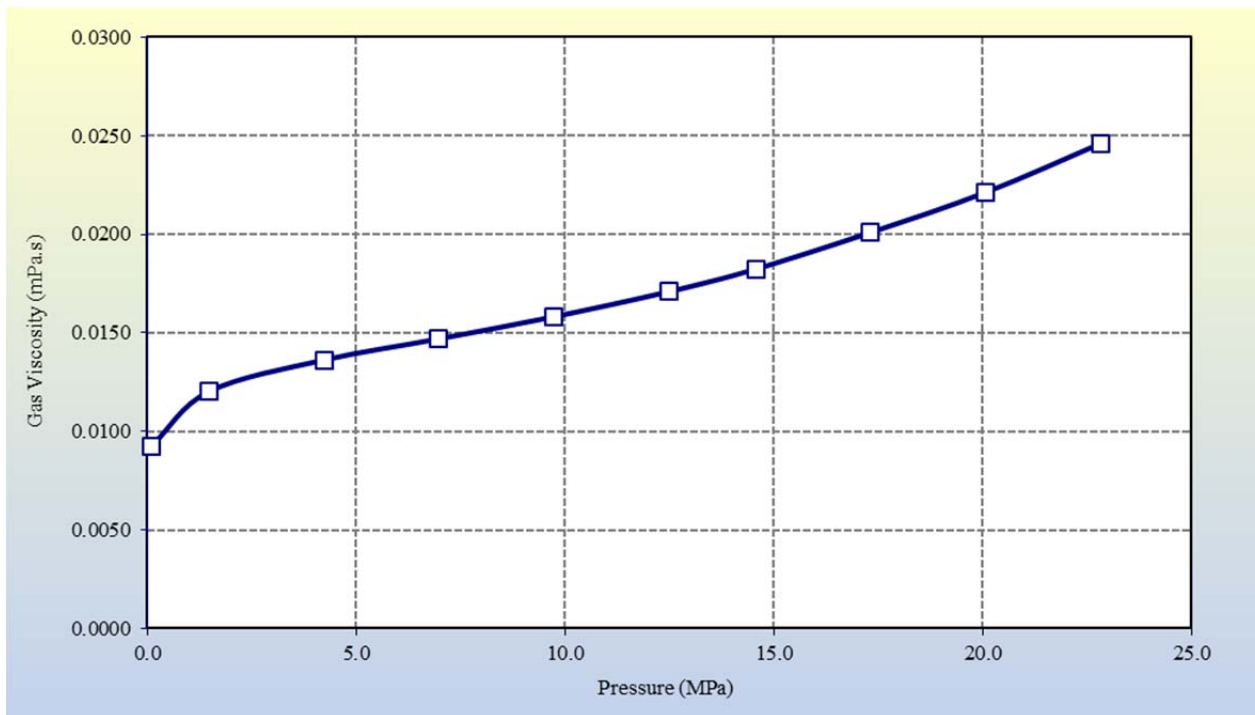
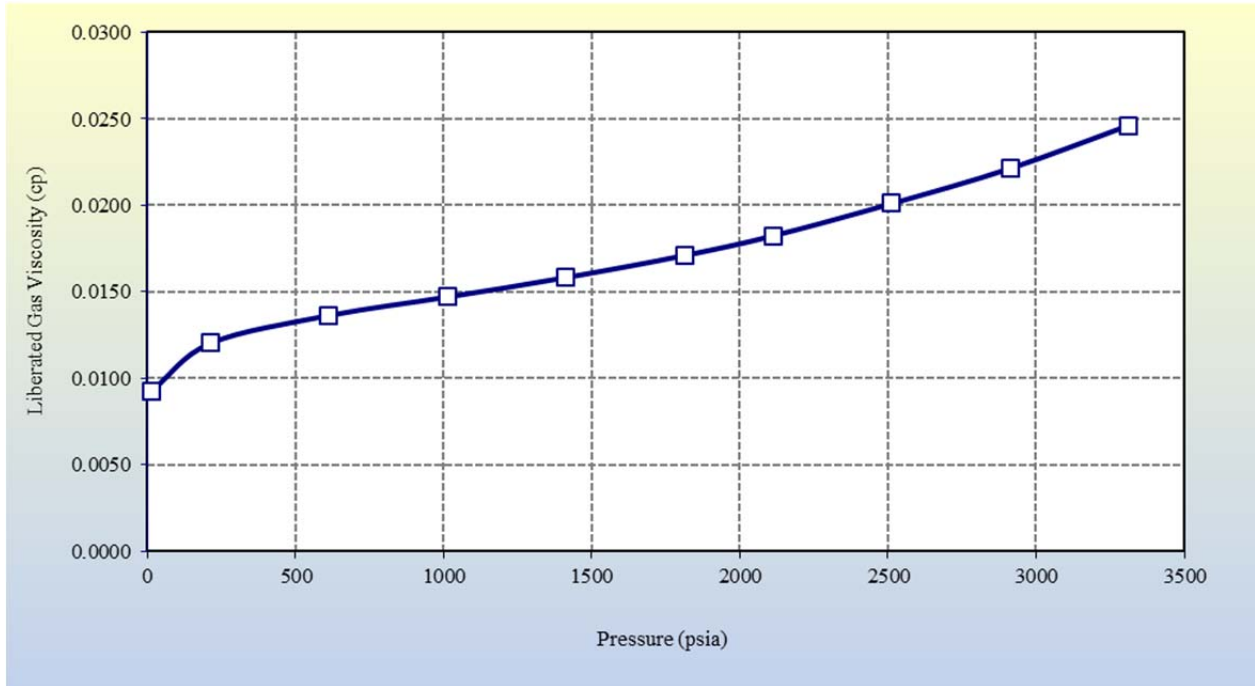
**FIGURE 7**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION GAS VOLUME FACTORS @ 229.7°F (109.8°C)**



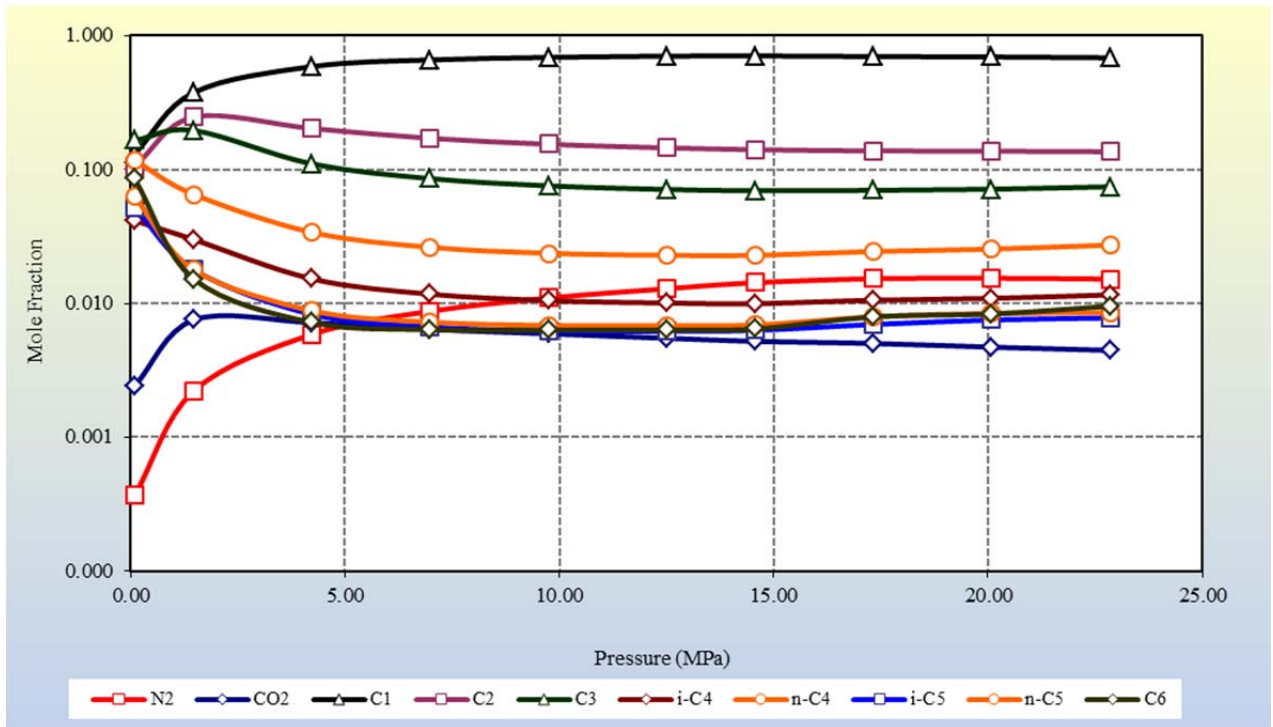
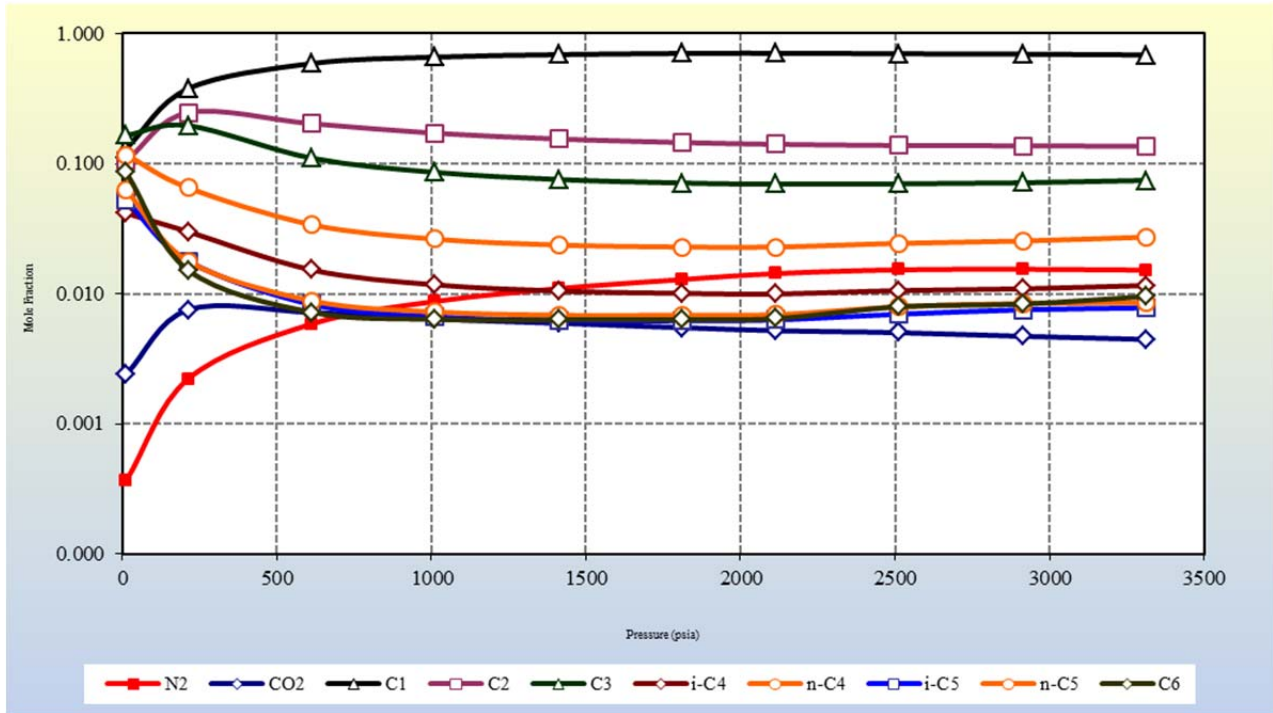
**FIGURE 8**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION GAS GRAVITY @ 229.7°F (109.8°C)**



**FIGURE 9**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION GAS VISCOSITY @ 229.7°F (109.8°C)**



**FIGURE 10**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**LIBERATED GAS COMPOSITION PROFILE @ 229.7°F (109.8°C)**



## **Multi-stage Separator Test**

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**TABLE 9  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
MULTI-STAGE SEPARATOR TEST OIL PROPERTIES**

Pressure		Temperature		Oil Density (g/cm <sup>3</sup> )	Oil Formation Volume Factor [1]	Total Formation Volume Factor [2]	Gas-Oil Ratio		Gas-Oil Ratio	
(psia)	(MPa)	(F)	(C)				Solution (scf/STB)	Liberated (scf/STB)	Solution (m <sup>3</sup> /m <sup>3</sup> )	Liberated (m <sup>3</sup> /m <sup>3</sup> )
<b>3724 Psat</b>	<b>25.67</b>	<b>230</b>	<b>110.0</b>	<b>0.5016</b>	<b>2.1783</b>	<b>2.1783</b>	<b>1802.83</b>	<b>0.00</b>	<b>321.09</b>	<b>0.00</b>
688	4.74	115	46.0	0.6905	1.2695	6.3859	397.10	1405.73	70.72	250.36
187	1.29	59	15.0	0.7290	1.1523	20.8259	213.99	1588.84	38.11	282.97
13	0.09	60	15.6	0.7843	1.0000	292.2236	0.00	1802.83	0.00	321.09

Density of Residual Oil = 0.7843 g/cm<sup>3</sup> (784.3 kg/m<sup>3</sup>) @ 60 F (288.7K)

API Gravity of Residual Oil = 48.9

[1] Barrels (Cubic meters) of oil at indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).

[2] Total barrels (cubic meters) of oil and liberated gas at the indicated pressure and temperature per barrel (cubic meter) of residual oil @ 60 F (288.7 K).

Psat - Saturation Pressure

- Tank conditions: 60 F (288.7 K) @ 13 psia (0.0896 MPa); Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa).



**TABLE 10  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
MULTI-STAGE SEPARATOR TEST GAS PROPERTIES**

Pressure		Temperature		Gas Gravity		Gas Density (g/cm <sup>3</sup> )	Gas Deviation Factor (-)	Gas Formation Volume Factor [1]	Gas Expansion Factor [2]
(psia)	(MPa)	(F)	(C)	Incremental (Air = 1)	Cumulative (Air = 1)				
<b>3724 Psat</b>	<b>25.67</b>	<b>230</b>	<b>110.0</b>						
688	4.74	115	46.0	0.7337	0.7337	0.0431	0.8814	0.0204	48.933
187	1.29	59	15.0	0.7842	0.7395	0.0129	0.9465	0.0695	14.383
13	0.09	60	15.6	1.3160	0.8079	0.0014	0.9892	0.9070	1.103

[1] Cubic feet (meters) of gas at indicated pressure and temperature per cubic feet (meter) @ standard conditions  
 [2] Cubic feet (meters) of gas @ standard conditions per cubic feet (meter) @ indicated pressure and temperature.  
 Psat - Saturation pressure  
 - Standard conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)



**TABLE 11  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF TANK OIL**

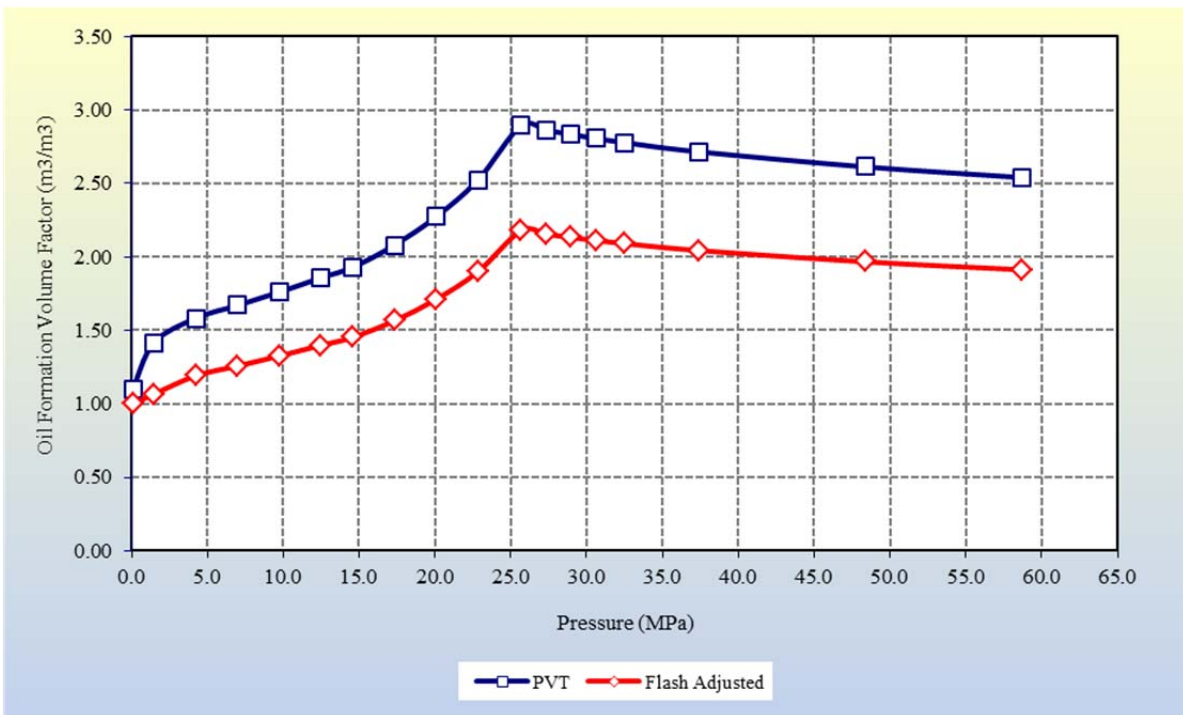
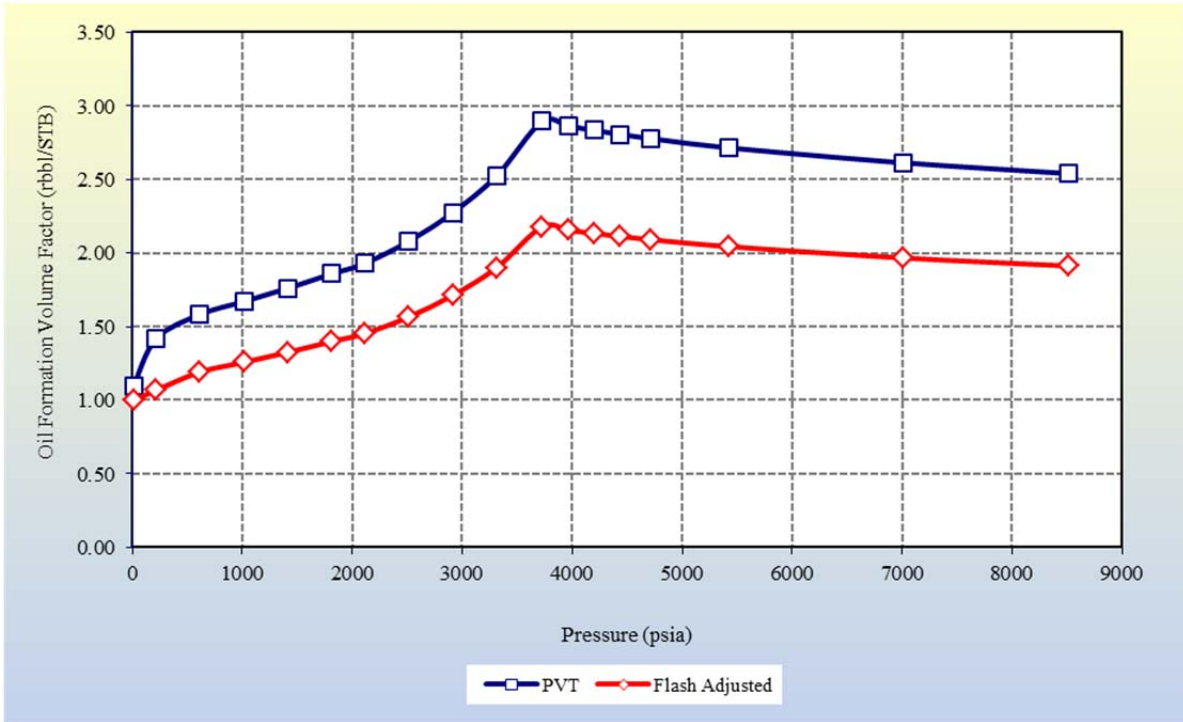
Boiling Point (C)			Mole Fraction	Mass Fraction	Calculated Properties
-195.8	Nitrogen	N2	0.0000	0.0000	<b>Total Sample</b>
-78.5	Carbon Dioxide	CO2	0.0000	0.0000	
-60.3	Hydrogen Sulphide	H2S	0.0000	0.0000	Molecular Weight 145.78
-161.7	Methane	C1	0.0000	0.0000	
-88.9	Ethane	C2	0.0000	0.0000	
-42.2	Propane	C3	0.0440	0.0133	<b>C6+ Fraction</b>
-11.7	i-Butane	i-C4	0.0178	0.0071	
-0.6	n-Butane	n-C4	0.0617	0.0246	Molecular Weight 167.67
27.8	i-Pentane	i-C5	0.0352	0.0174	Mole Fraction 0.7954
36.1	n-Pentane	n-C5	0.0459	0.0227	Density (g/cc) 0.8202
36.1 - 68.9	Hexanes	C6	0.0855	0.0505	
68.9 - 98.3	Heptanes	C7	0.0810	0.0557	
98.3 - 125.6	Octanes	C8	0.0912	0.0715	<b>C7+ Fraction</b>
125.6 - 150.6	Nonanes	C9	0.0662	0.0583	
150.6 - 173.9	Decanes	C10	0.0506	0.0494	Molecular Weight 178.08
173.9 - 196.1	Undecanes	C11	0.0453	0.0457	Mole Fraction 0.7061
196.1 - 215	Dodecanes	C12	0.0347	0.0383	Density (g/cc) 0.8300
215 - 235	Tridecanes	C13	0.0353	0.0423	
235 - 252.2	Tetradecanes	C14	0.0288	0.0375	
252.2 - 270.6	Pentadecanes	C15	0.0212	0.0300	<b>C12+ Fraction</b>
270.6 - 287.8	Hexadecanes	C16	0.0169	0.0257	
287.8 - 291.7	Heptadecanes	C17	0.0145	0.0236	Molecular Weight 275.99
291.7 - 317.2	Octadecanes	C18	0.0138	0.0238	Mole Fraction 0.2723
317.2 - 330	Nonadecanes	C19	0.0123	0.0222	Density (g/cc) 0.8788
330 - 344.4	Eicosanes	C20	0.0097	0.0184	
344.4 - 357.2	Heneicosanes	C21	0.0087	0.0174	
357.2 - 369.4	Docosanes	C22	0.0073	0.0152	
369.4 - 380	Tricosanes	C23	0.0066	0.0145	
380 - 391.1	Tetracosanes	C24	0.0057	0.0130	
391.1 - 401.7	Pentacosanes	C25	0.0052	0.0122	
401.7 - 412.2	Hexacosanes	C26	0.0043	0.0107	
412.3 - 422.2	Heptacosanes	C27	0.0039	0.0100	
422.3 - 431.7	Octacosanes	C28	0.0037	0.0098	
431.7 - 441.1	Nonacosanes	C29	0.0031	0.0086	
Above 441.1	Tricontanes Plus	C30+	0.0365	0.1422	
48.9	Cyclopentane	C5H10	0.0038	0.0018	
72.2	Methylcyclopentane	C6H12	0.0153	0.0088	
81.1	Cyclohexane	C6H12	0.0127	0.0073	
101.1	Methylcyclohexane	C7H14	0.0321	0.0216	
80.0	Benzene	C6H6	0.0020	0.0010	
110.6	Toluene	C7H8	0.0081	0.0051	
136.1 - 138.9	Ethylbenzene & p,m-Xylene	C8H10	0.0092	0.0067	
144.4	o-Xylene	C8H10	0.0072	0.0052	
168.9	1, 2, 4-Trimethylbenzene	C9H12	0.0130	0.0107	
<b>Total</b>			<b>1.0000</b>	<b>1.0000</b>	

**TABLE 12  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
FLASH ADJUSTED DIFFERENTIAL LIBERATION DATA**

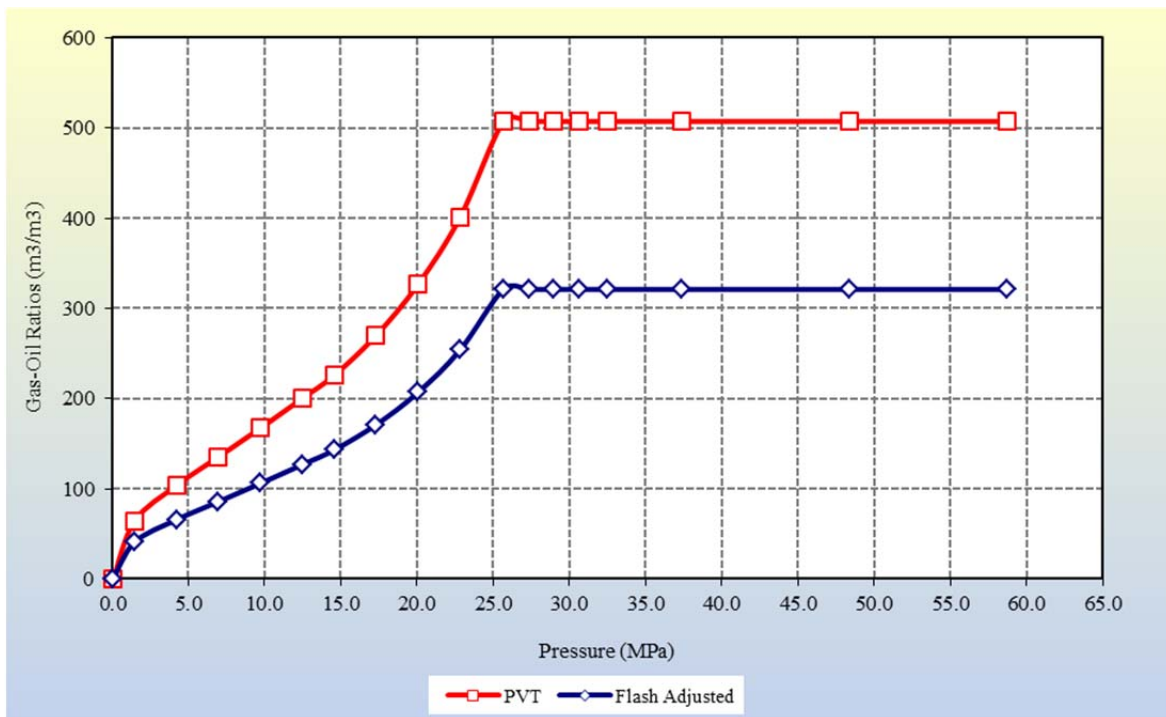
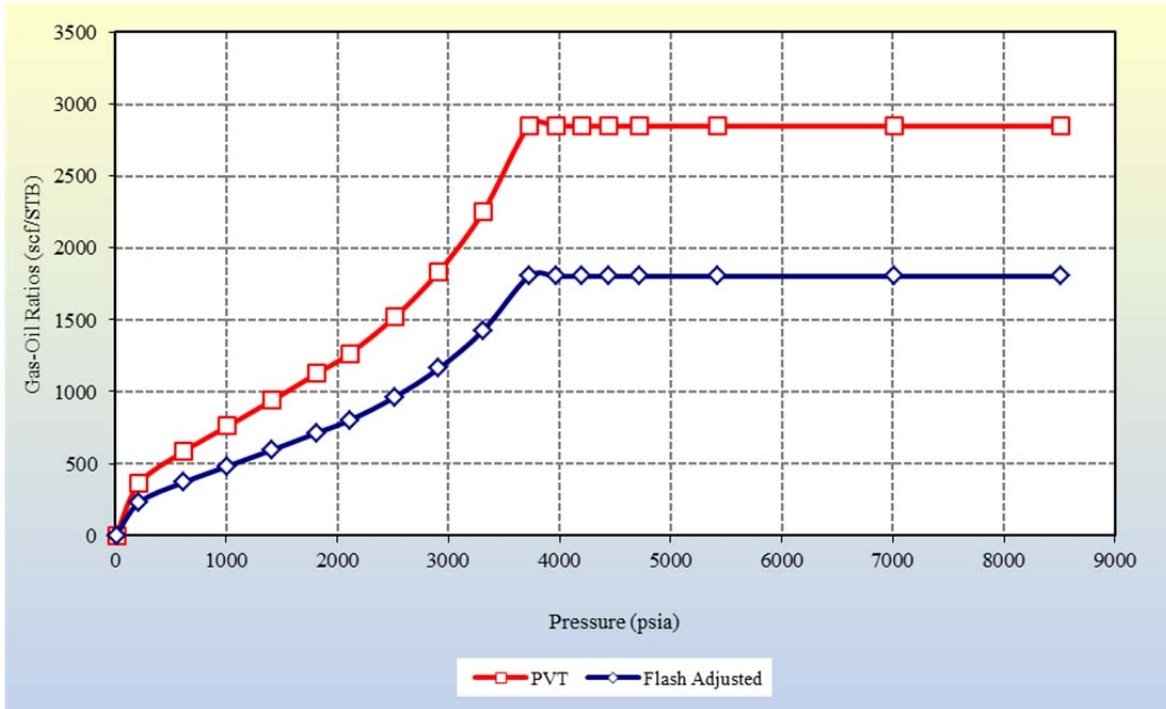
Pressure		Oil Formation Volume Factor		Solution Gas-Oil Ratio			
(psia)	(MPa)	PVT	Flash Adjusted	PVT	Flash Adjusted	PVT	Flash Adjusted
				(scf/STB)	(scf/STB)	(m <sup>3</sup> /m <sup>3</sup> )	(m <sup>3</sup> /m <sup>3</sup> )
8513	58.69	2.5407	1.9123	2847.67	1802.73	507.17	321.09
7013	48.35	2.6133	1.9669	2847.67	1802.73	507.17	321.09
5422	37.38	2.7157	2.0440	2847.67	1802.73	507.17	321.09
4717	32.52	2.7778	2.0907	2847.67	1802.73	507.17	321.09
4440	30.61	2.8068	2.1126	2847.67	1802.73	507.17	321.09
4198	28.94	2.8341	2.1331	2847.67	1802.73	507.17	321.09
3966	27.34	2.8623	2.1544	2847.67	1802.73	507.17	321.09
<b>3724 Psat</b>	<b>25.67</b>	<b>2.8942</b>	<b>2.1783</b>	<b>2847.67</b>	<b>1802.73</b>	<b>507.17</b>	<b>321.09</b>
3313	22.84	2.5250	1.9004	2253.05	1426.30	401.27	254.04
2913	20.08	2.2746	1.7120	1835.27	1161.83	326.86	206.93
2513	17.33	2.0801	1.5656	1516.50	960.02	270.09	170.99
2113	14.57	1.9298	1.4525	1266.39	801.69	225.54	142.79
1813	12.50	1.8585	1.3988	1125.05	712.22	200.37	126.85
1413	9.74	1.7608	1.3253	939.13	594.52	167.26	105.89
1013	6.98	1.6701	1.2570	759.57	480.85	135.28	85.64
613	4.23	1.5822	1.1909	581.18	367.92	103.51	65.53
213	1.47	1.4167	1.0663	359.66	227.68	64.05	40.55
13	0.09	1.0975	1.0000	0.00	0.00	0.00	0.00

Psat - Saturation Pressure

**FIGURE 11**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION OIL FORMATION VOLUME FACTOR @ 229.7°F (109.8°C)**



**FIGURE 12**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION GAS-OIL RATIOS @ 229.7°F (109.8°C)**



## **CCE at Different Temperatures**

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**TABLE 13**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**SATURATION PRESSURES AT DIFFERENT TEMPERATURES**

Temperature		Saturation Pressure		
°F	°C	Psia	Mpa	Psat
176	80	3401	23.4	Pb
230	110	3724	25.7	Pb
320	160	3864	26.6	Pb
410	210	3716	25.6	Pb

**TABLE 14**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**AVERAGE FLUID COMPRESSIBILITIES @ 176.0°F (80.0°C)**

Pressure Range		Average Fluid Compressibility (psi <sup>-1</sup> )
From (psia)	To (psia)	
8513	7013	1.7048E-05
7013	5513	2.1626E-05
5513	4713	2.8185E-05
4713	4151	3.3347E-05
4151	3809	3.7637E-05
3809	3510	4.0803E-05
<b>3510</b>	<b>3401 Psat</b>	<b>4.4979E-05</b>

Pressure Range		Average Fluid Compressibility (MPa <sup>-1</sup> )
From (MPa)	To (MPa)	
58.69	48.35	2.4727E-03
48.35	38.01	3.1366E-03
38.01	32.49	4.0878E-03
32.49	28.62	4.8366E-03
28.62	26.26	5.4587E-03
26.26	24.20	5.9180E-03
<b>24.20</b>	<b>23.45 Psat</b>	<b>6.5236E-03</b>

Psat - Saturation Pressure

**TABLE 15**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**CONSTANT COMPOSITION EXPANSION @ 176.0°F (80.0°C)**

Pressure		Relative Volume [1]	Y-Function [2]	Liquid Volume (% of Vtot)	Fluid Density (g/cc)
(psia)	(MPa)				
8513	58.69	0.8774			0.6037
7013	48.35	0.9005			0.5883
5513	38.01	0.9307			0.5692
4713	32.49	0.9521			0.5563
4151	28.62	0.9703			0.5459
3809	26.26	0.9830			0.5389
3510	24.20	0.9951			0.5323
<b>3401 *</b>	<b>23.45</b>	<b>1.0000</b>		<b>100.00</b>	<b>0.5297</b>
3251	22.41	1.0191	2.4185	86.02	
3101	21.38	1.0410	2.3606	80.59	
2951	20.34	1.0662	2.3026	76.32	
2801	19.31	1.0954	2.2447	72.65	
2651	18.28	1.1294	2.1867	69.55	
2501	17.24	1.1691	2.1287	64.82	
2351	16.21	1.2157	2.0708	60.54	
2201	15.17	1.2709	2.0128	57.01	
2051	14.14	1.3367	1.9549	52.93	
1901	13.11	1.4160	1.8969	49.14	
1751	12.07	1.5125	1.8389	45.30	
1601	11.04	1.6314	1.7810	41.19	
1451	10.00	1.7801	1.7230	36.88	
1301	8.97	1.9696	1.6651	32.88	
1151	7.93	2.2166	1.6071	28.85	

[1] Volume at indicated pressure per volume at saturation pressure  
 [2] YFunction = ((Psat-P)/P)/(Relative Volume - 1)  
 \* Saturation Pressure



**TABLE 16**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**AVERAGE FLUID COMPRESSIBILITIES @ 229.6°F (109.8°C)**

Pressure Range		Average Fluid Compressibility (psi <sup>-1</sup> )
From (psia)	To (psia)	
8513	7013	1.8508E-05
7013	5422	2.3697E-05
5422	4717	3.1725E-05
4717	4440	3.7331E-05
4440	4198	3.9808E-05
4198	3966	4.2474E-05
<b>3966</b>	<b>3724 Psat</b>	<b>4.5481E-05</b>

Pressure Range		Average Fluid Compressibility (MPa <sup>-1</sup> )
From (MPa)	To (MPa)	
58.69	48.35	2.6843E-03
48.35	37.38	3.4369E-03
37.38	32.52	4.6013E-03
32.52	30.61	5.4144E-03
30.61	28.94	5.7736E-03
28.94	27.34	6.1603E-03
<b>27.34</b>	<b>25.67 Psat</b>	<b>6.5964E-03</b>

Psat - Saturation Pressure

**TABLE 17  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
CONSTANT COMPOSITION EXPANSION @ 229.6°F (109.8°C)**

Pressure		Relative Volume [1]	Y-Function [2]	Liquid Volume (% of Vtot)	Fluid Density (g/cc)
(psia)	(MPa)				
8513	58.69	0.8779			0.5714
7013	48.35	0.9029			0.5555
5422	37.38	0.9383			0.5346
4717	32.52	0.9598			0.5226
4440	30.61	0.9698			0.5172
4198	28.94	0.9792			0.5122
3966	27.34	0.9890			0.5072
<b>3724 *</b>	<b>25.67</b>	<b>1.0000</b>		<b>100.00</b>	<b>0.5016</b>
3563	24.56	1.0178	2.5442	88.06	
3402	23.45	1.0383	2.4737	81.69	
3241	22.34	1.0620	2.4031	75.78	
3080	21.23	1.0896	2.3325	71.19	
2919	20.12	1.1219	2.2620	67.28	
2758	19.01	1.1598	2.1914	63.04	
2597	17.90	1.2046	2.1208	59.22	
2436	16.79	1.2579	2.0503	55.44	
2275	15.68	1.3218	1.9797	51.66	
2114	14.57	1.3990	1.9091	47.50	
1953	13.46	1.4933	1.8386	44.10	
1792	12.35	1.6099	1.7680	40.12	
1631	11.24	1.7561	1.6974	36.17	
1470	10.13	1.9427	1.6269	31.95	
1309	9.02	2.1857	1.5563	27.90	

[1] Volume at indicated pressure per volume at saturation pressure  
 [2] Y Function = ((Psat-P)/P)/(Relative Volume - 1)  
 \* Saturation Pressure

**TABLE 18**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**AVERAGE FLUID COMPRESSIBILITIES @ 320.0°F (160.0°C)**

Pressure Range		Average Fluid Compressibility (psi <sup>-1</sup> )
From (psia)	To (psia)	
8513	7013	2.5571E-05
7013	5413	3.2678E-05
5413	4811	4.4581E-05
4811	4467	5.3684E-05
4467	4161	6.0931E-05
4161	4023	6.9653E-05
<b>4023</b>	<b>3864 Psat</b>	<b>7.4375E-05</b>

Pressure Range		Average Fluid Compressibility (MPa <sup>-1</sup> )
From (MPa)	To (MPa)	
58.69	48.35	3.7088E-03
48.35	37.32	4.7396E-03
37.32	33.17	6.4660E-03
33.17	30.80	7.7862E-03
30.80	28.69	8.8374E-03
28.69	27.74	1.0102E-02
<b>27.74</b>	<b>26.64 Psat</b>	<b>1.0787E-02</b>

Psat - Saturation Pressure

**TABLE 19  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
CONSTANT COMPOSITION EXPANSION @ 320.0°F (160.0°C)**

Pressure		Relative Volume [1]	Y-Function [2]	Liquid Volume (% of Vtot)	Fluid Density (g/cc)
(psia)	(MPa)				
8513	58.69	0.8361			0.5355
7013	48.35	0.8694			0.5150
5413	37.32	0.9174			0.4881
4811	33.17	0.9427			0.4750
4467	30.80	0.9604			0.4662
4161	28.69	0.9787			0.4575
4023	27.74	0.9882			0.4531
<b>3864 *</b>	<b>26.64</b>	<b>1.0000</b>		<b>100.00</b>	<b>0.4477</b>
3746	25.83	1.0149	2.1132	82.64	
3598	24.81	1.0359	2.0610	72.60	
3450	23.79	1.0597	2.0088	67.59	
3302	22.76	1.0870	1.9567	63.32	
3154	21.74	1.1182	1.9045	59.75	
3006	20.72	1.1541	1.8524	56.93	
2858	19.70	1.1955	1.8002	53.92	
2710	18.68	1.2436	1.7480	51.26	
2562	17.66	1.2997	1.6959	48.53	
2414	16.64	1.3655	1.6437	44.52	
2266	15.62	1.4431	1.5915	40.94	
2118	14.60	1.5356	1.5394	37.88	
1970	13.58	1.6465	1.4872	34.43	
1822	12.56	1.7811	1.4351	31.21	
1674	11.54	1.9461	1.3829	27.96	

[1] Volume at indicated pressure per volume at saturation pressure  
 [2] Y Function = ((Psat-P)/P)/(Relative Volume - 1)  
 \* Saturation Pressure

**TABLE 20**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**AVERAGE FLUID COMPRESSIBILITIES @ 410.0°F (210.0°C)**

Pressure Range		Average Fluid Compressibility (psi <sup>-1</sup> )
From (psia)	To (psia)	
5013	4809	7.1073E-05
4809	4463	7.4979E-05
4463	4170	8.3384E-05
4170	4039	9.3654E-05
4039	3923	1.0113E-04
3923	3813	1.1177E-04
3813	3716 Psat	1.2374E-04

Pressure Range		Average Fluid Compressibility (MPa <sup>-1</sup> )
From (MPa)	To (MPa)	
34.56	33.16	1.0308E-02
33.16	30.77	1.0875E-02
30.77	28.75	1.2094E-02
28.75	27.85	1.3583E-02
27.85	27.05	1.4667E-02
27.05	26.29	1.6210E-02
<b>26.29</b>	<b>25.62 Psat</b>	<b>1.7947E-02</b>

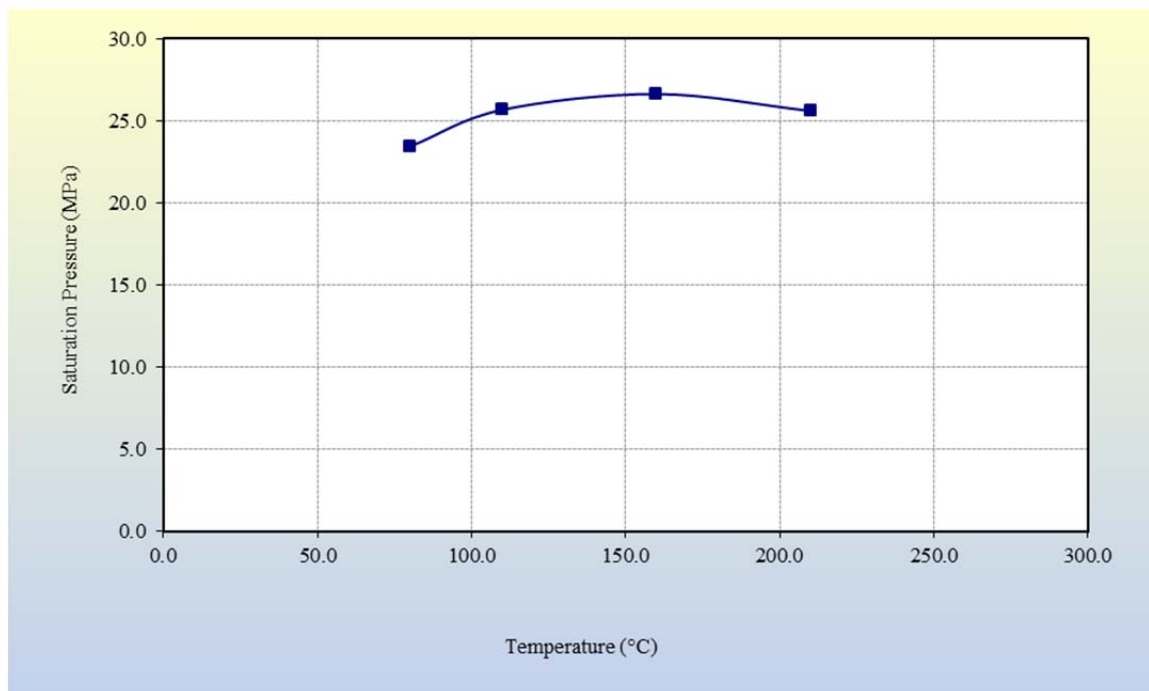
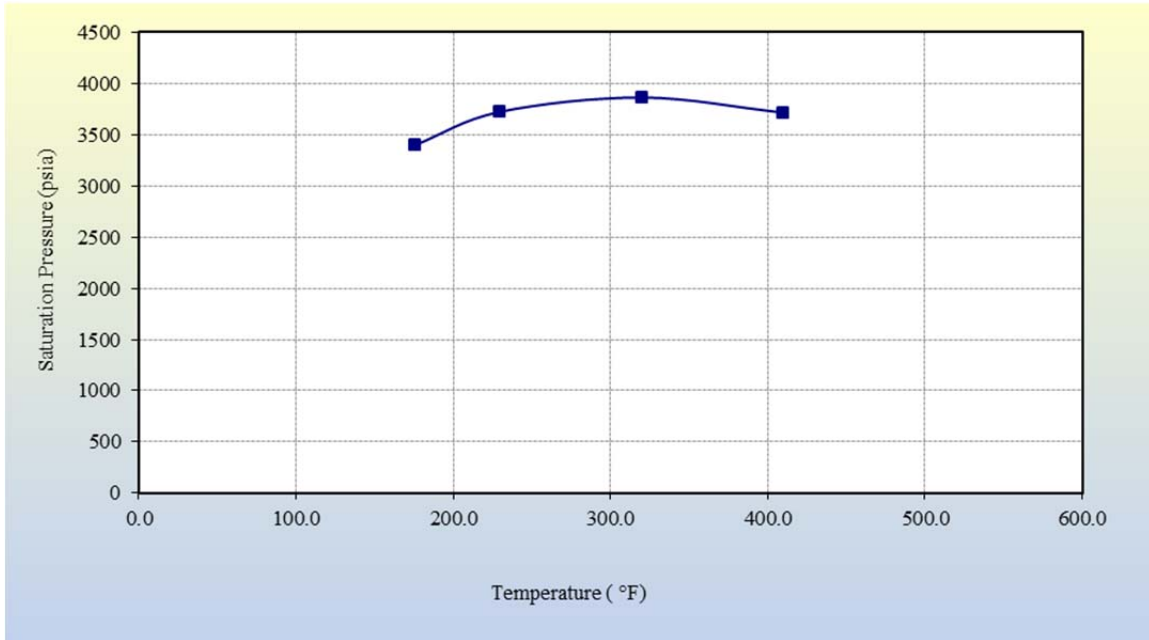
Psat - Saturation Pressure

**TABLE 21  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
CONSTANT COMPOSITION EXPANSION @ 410.0°F (210.0°C)**

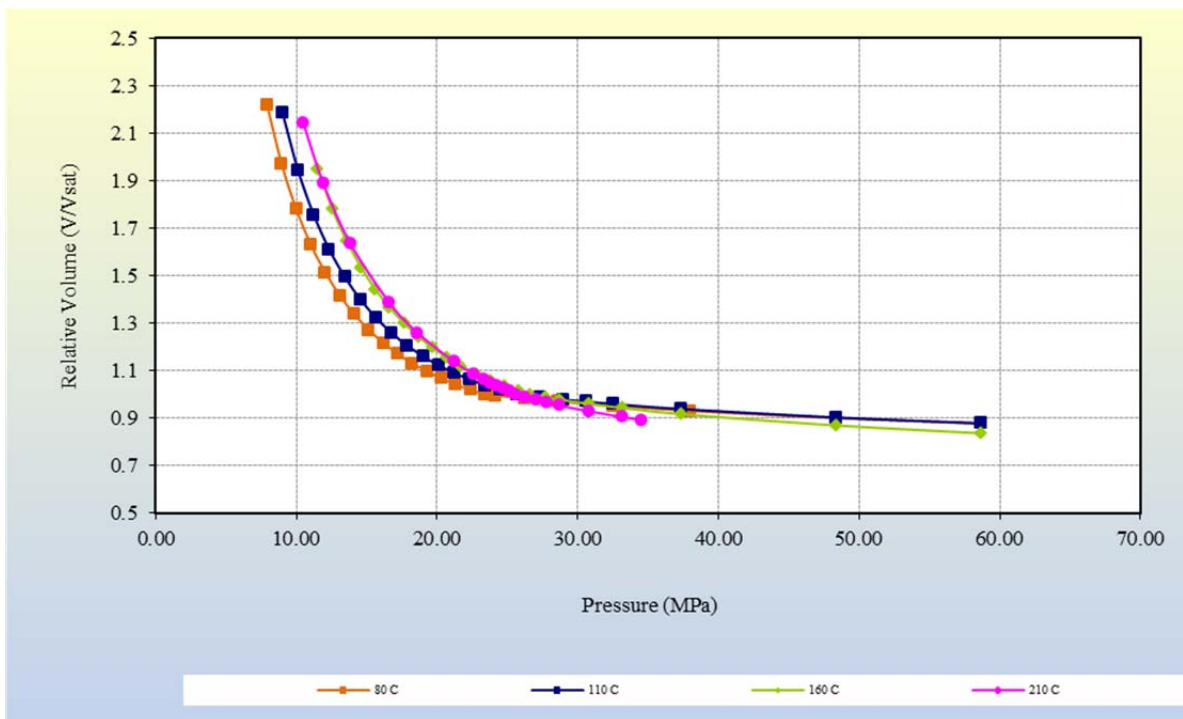
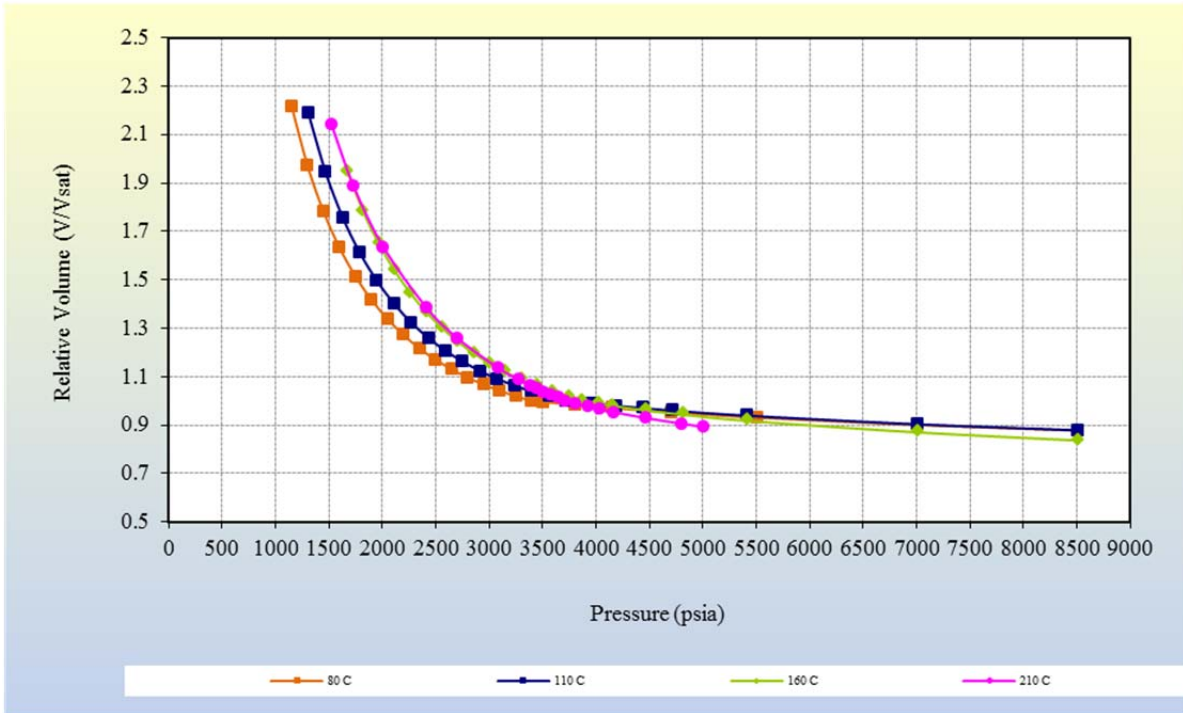
Pressure		Relative Volume [1]	Y-Function [2]	Liquid Volume (% of Vtot)	Fluid Density (g/cc)
(psia)	(MPa)				
5013	34.56	0.8921			0.4510
4809	33.16	0.9052			0.4445
4463	30.77	0.9293			0.4329
4170	28.75	0.9526			0.4224
4039	27.85	0.9644			0.4172
3923	27.05	0.9759			0.4123
3813	26.29	0.9880			0.4072
<b>3716 *</b>	<b>25.62</b>	<b>1.0000</b>		<b>100.00</b>	<b>0.4023</b>
3647	25.14	1.0118	1.6008	58.81	
3577	24.66	1.0244	1.5895	52.93	
3511	24.21	1.0370	1.5789	50.02	
3451	23.79	1.0489	1.5692	48.42	
3391	23.38	1.0615	1.5596	47.12	
3282	22.63	1.0858	1.5421	45.32	
3083	21.25	1.1360	1.5100	41.97	
2700	18.61	1.2598	1.4484	35.78	
2414	16.64	1.3846	1.4024	31.83	
2009	13.85	1.6355	1.3372	26.81	
1731	11.93	1.8873	1.2925	22.29	
1524	10.51	2.1424	1.2592	19.62	

[1] Volume at indicated pressure per volume at saturation pressure  
 [2] Y Function = ((Psat-P)/P)/(Relative Volume - 1)  
 \* Saturation Pressure

**FIGURE 13**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**SATURATION PRESSURES AT DIFFERENT TEMPERATURES**

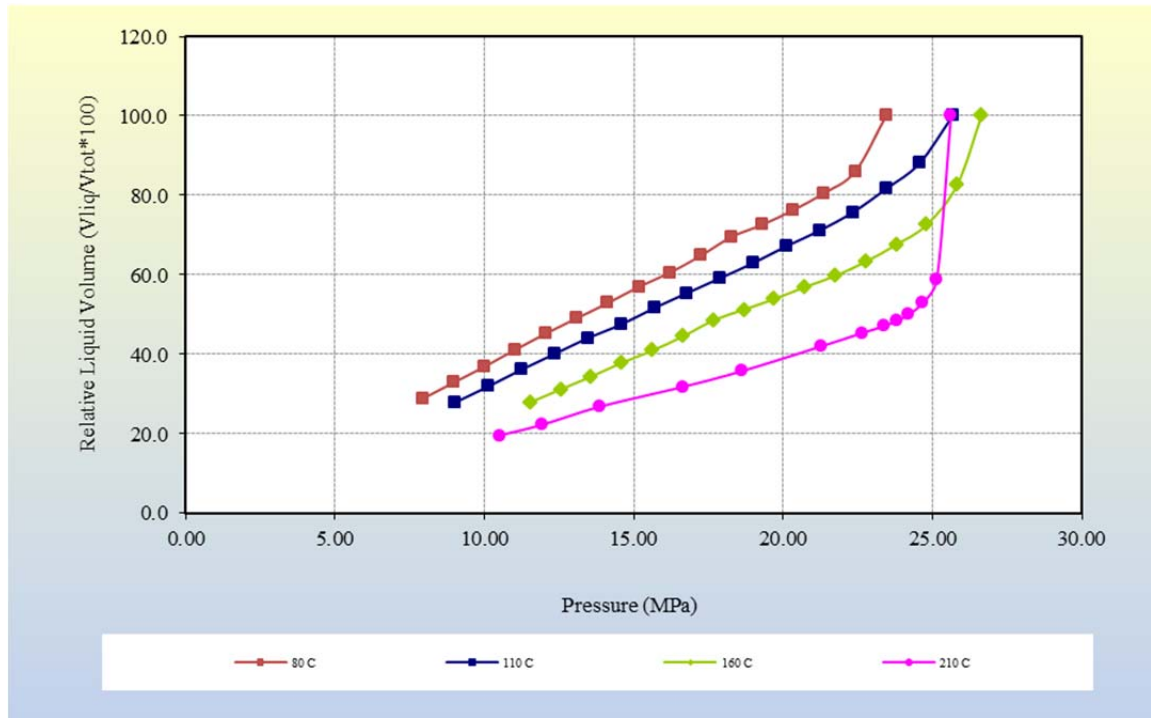
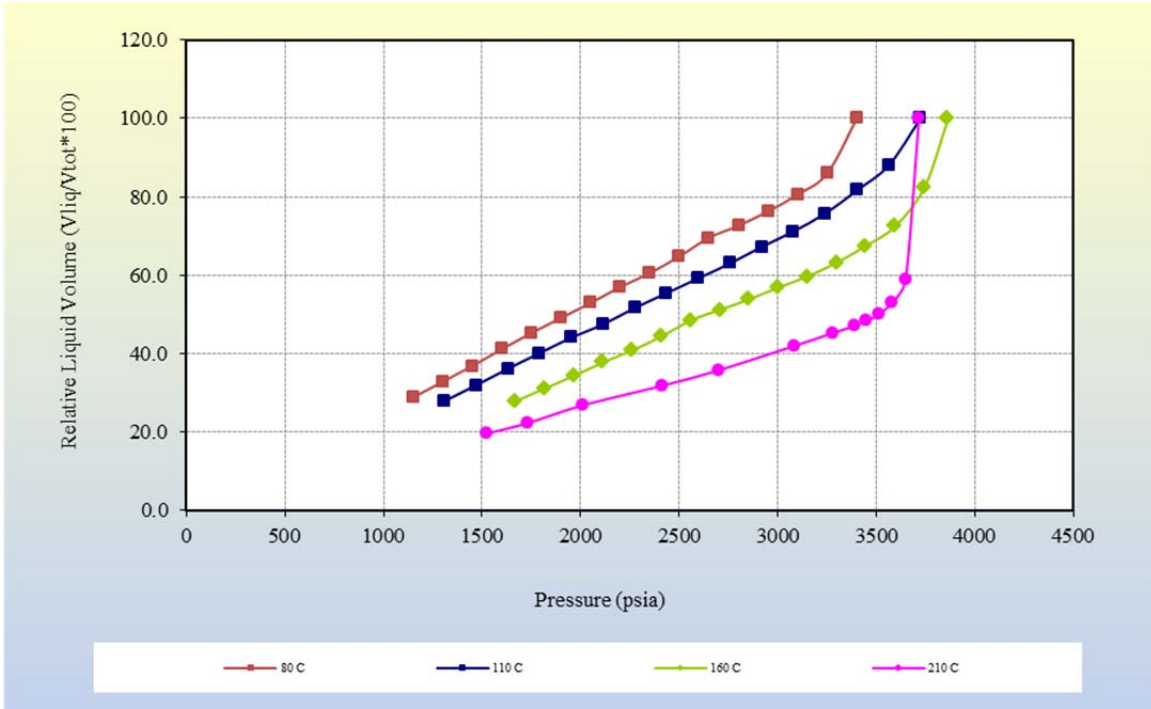


**FIGURE 14**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**CCE @ DIFFERENT TEMPERATURES-RELATIVE VOLUMES**

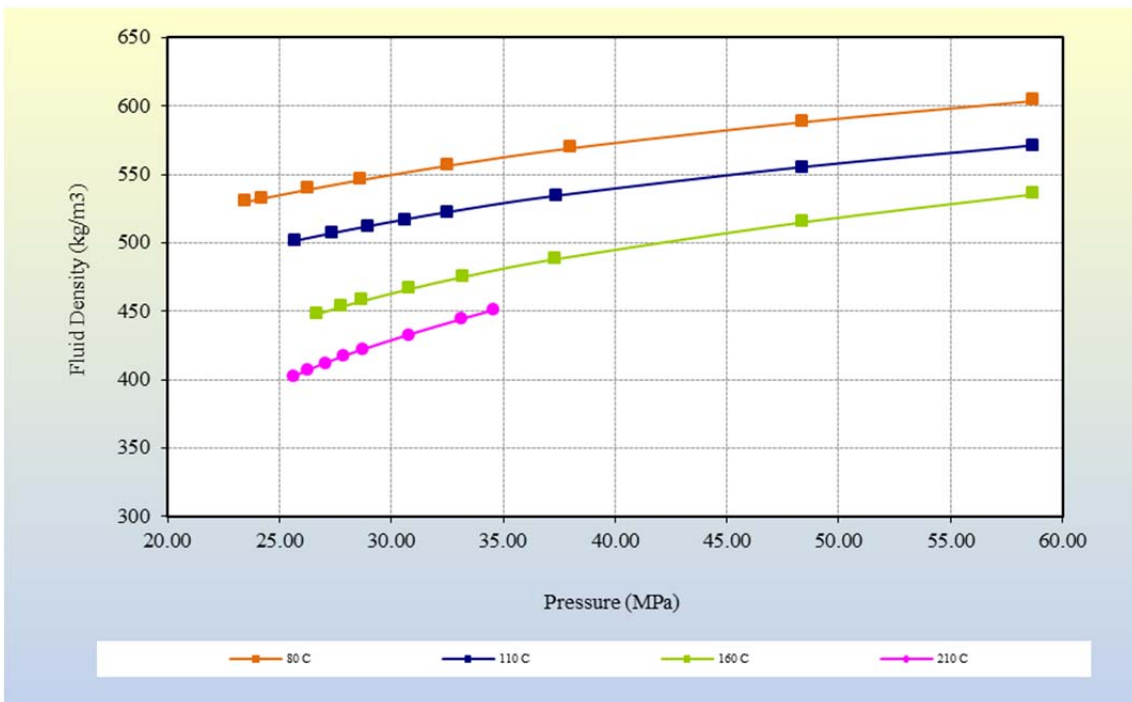
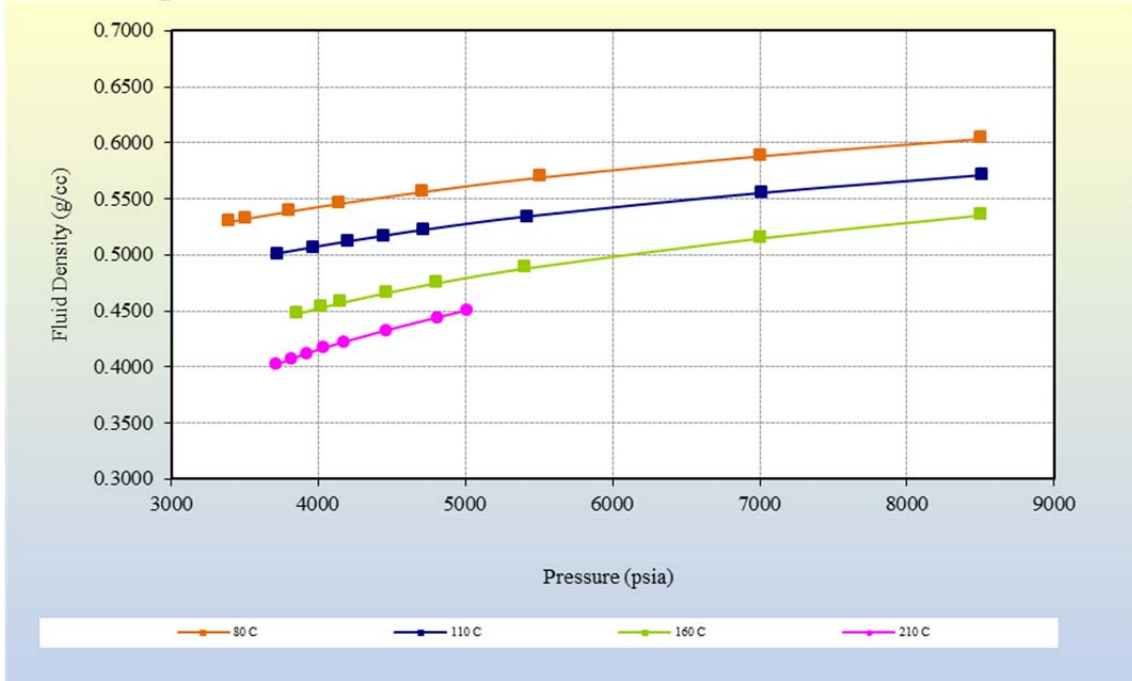




**FIGURE 15**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**CCE @ DIFFERENT TEMPERATURES-RELATIVE LIQUID PHASE**  
**VOLUMES BELOW PSAT**



**FIGURE 16**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**CCE @ DIFFERENT TEMPERATURES-FLUID DENSITIES ABOVE PSAT**



## Appendix A

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### RECOMBINED FLUID COMPOSITION

**TABLE A1  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF RESERVOIR FLUID**

Boiling Point (C)	Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties
-195.8	Nitrogen	N <sub>2</sub>	0.0095	0.0046	<b>Total Sample</b>
-78.5	Carbon Dioxide	CO <sub>2</sub>	0.0043	0.0033	
-60.3	Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000	Molecular Weight 57.16
-161.7	Methane	C <sub>1</sub>	0.4825	0.1355	Density (g/cc) 0.5881
-88.9	Ethane	C <sub>2</sub>	0.1254	0.0659	
-42.2	Propane	C <sub>3</sub>	0.0822	0.0634	<b>C<sub>6+</sub> Fraction</b>
-11.7	i-Butane	i-C <sub>4</sub>	0.0140	0.0143	
-0.6	n-Butane	n-C <sub>4</sub>	0.0356	0.0362	Molecular Weight 167.92
27.8	i-Pentane	i-C <sub>5</sub>	0.0129	0.0163	Mole Fraction 0.2181
36.1	n-Pentane	n-C <sub>5</sub>	0.0156	0.0197	Density (g/cc) 0.8200
36.1 - 68.9	Hexanes	C <sub>6</sub>	0.0244	0.0368	
68.9 - 98.3	Heptanes	C <sub>7</sub>	0.0223	0.0391	<b>C<sub>7+</sub> Fraction</b>
98.3 - 125.6	Octanes	C <sub>8</sub>	0.0245	0.0490	
125.6 - 150.6	Nonanes	C <sub>9</sub>	0.0179	0.0402	Molecular Weight 178.73
150.6 - 173.9	Decanes	C <sub>10</sub>	0.0136	0.0339	Mole Fraction 0.1928
173.9 - 196.1	Undecanes	C <sub>11</sub>	0.0122	0.0313	Density (g/cc) 0.8302
196.1 - 215	Dodecanes	C <sub>12</sub>	0.0097	0.0272	
215 - 235	Tridecanes	C <sub>13</sub>	0.0095	0.0292	<b>C<sub>12+</sub> Fraction</b>
235 - 252.2	Tetradecanes	C <sub>14</sub>	0.0079	0.0262	
252.2 - 270.6	Pentadecanes	C <sub>15</sub>	0.0058	0.0208	Molecular Weight 275.39
270.6 - 287.8	Hexadecanes	C <sub>16</sub>	0.0047	0.0181	Mole Fraction 0.0754
287.8 - 291.7	Heptadecanes	C <sub>17</sub>	0.0040	0.0167	Density (g/cc) 0.8780
291.7 - 317.2	Octadecanes	C <sub>18</sub>	0.0039	0.0170	
317.2 - 330	Nonadecanes	C <sub>19</sub>	0.0034	0.0159	<b>C<sub>30+</sub> Fraction</b>
330 - 344.4	Eicosanes	C <sub>20</sub>	0.0028	0.0133	
344.4 - 357.2	Heneicosanes	C <sub>21</sub>	0.0024	0.0122	Molecular Weight 568.29
357.2 - 369.4	Docosanes	C <sub>22</sub>	0.0021	0.0114	Mole Fraction 0.0097
369.4 - 380	Tricosanes	C <sub>23</sub>	0.0019	0.0106	Density (g/cc) 0.9824
380 - 391.1	Tetracosanes	C <sub>24</sub>	0.0017	0.0097	
391.1 - 401.7	Pentacosanes	C <sub>25</sub>	0.0015	0.0092	
401.7 - 412.2	Hexacosanes	C <sub>26</sub>	0.0013	0.0084	<b>Recombination Parameters</b>
412.3 - 422.2	Heptacosanes	C <sub>27</sub>	0.0012	0.0076	
422.3 - 431.7	Octacosanes	C <sub>28</sub>	0.0011	0.0072	Gas-Oil Ratio (cc/cc) 363.07
431.7 - 441.1	Nonacosanes	C <sub>29</sub>	0.0009	0.0066	Dead Oil Density (g/cc) 0.7922
Above 441.1	Tricontanes Plus	C <sub>30+</sub>	0.0097	0.0961	Dead Oil MW (g/mol) 152.92
	<b>NAPHTHENES</b>				
48.9	Cyclopentane	C <sub>5</sub> H <sub>10</sub>	0.0009	0.0011	
72.2	Methylcyclopentane	C <sub>6</sub> H <sub>12</sub>	0.0039	0.0058	
81.1	Cyclohexane	C <sub>6</sub> H <sub>12</sub>	0.0033	0.0048	
101.1	Methylcyclohexane	C <sub>7</sub> H <sub>14</sub>	0.0088	0.0151	
	<b>AROMATICICS</b>				
80.0	Benzene	C <sub>6</sub> H <sub>6</sub>	0.0005	0.0007	
110.6	Toluene	C <sub>7</sub> H <sub>8</sub>	0.0022	0.0035	
136.1 - 138.9	Ethylbenzene & p,m-Xyle	C <sub>8</sub> H <sub>10</sub>	0.0025	0.0046	
144.4	o-Xylene	C <sub>8</sub> H <sub>10</sub>	0.0020	0.0037	
168.9	1, 2, 4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	0.0037	0.0078	
<b>Total</b>			<b>1.0000</b>	<b>1.0000</b>	

Note: Physical Properties calculated based GPA 2145-00 physical constants

**TABLE A2  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF FLASHED OIL**

Boiling Point (C)	Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties
-195.8	Nitrogen	N <sub>2</sub>	0.0000	0.0000	<b>Total Sample</b>
-78.5	Carbon Dioxide	CO <sub>2</sub>	0.0000	0.0000	
-60.3	Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000	Molecular Weight 152.92
-161.7	Methane	C <sub>1</sub>	0.0000	0.0000	Density (g/cc) 0.8016
-88.9	Ethane	C <sub>2</sub>	0.0000	0.0000	
-42.2	Propane	C <sub>3</sub>	0.0282	0.0081	<b>C<sub>6+</sub> Fraction</b>
-11.7	i-Butane	i-C <sub>4</sub>	0.0118	0.0045	
-0.6	n-Butane	n-C <sub>4</sub>	0.0441	0.0167	Molecular Weight 169.59
27.8	i-Pentane	i-C <sub>5</sub>	0.0299	0.0141	Mole Fraction 0.8451
36.1	n-Pentane	n-C <sub>5</sub>	0.0409	0.0193	Density (g/cc) 0.8216
36.1 - 68.9	Hexanes	C <sub>6</sub>	0.0845	0.0476	
68.9 - 98.3	Heptanes	C <sub>7</sub>	0.0842	0.0552	<b>C<sub>7+</sub> Fraction</b>
98.3 - 125.6	Octanes	C <sub>8</sub>	0.0964	0.0720	
125.6 - 150.6	Nonanes	C <sub>9</sub>	0.0706	0.0592	Molecular Weight 179.38
150.6 - 173.9	Decanes	C <sub>10</sub>	0.0539	0.0501	Mole Fraction 0.7570
173.9 - 196.1	Undecanes	C <sub>11</sub>	0.0482	0.0464	Density (g/cc) 0.8306
196.1 - 215	Dodecanes	C <sub>12</sub>	0.0383	0.0403	
215 - 235	Tridecanes	C <sub>13</sub>	0.0378	0.0432	<b>C<sub>12+</sub> Fraction</b>
235 - 252.2	Tetradecanes	C <sub>14</sub>	0.0312	0.0387	
252.2 - 270.6	Pentadecanes	C <sub>15</sub>	0.0228	0.0307	Molecular Weight 275.39
270.6 - 287.8	Hexadecanes	C <sub>16</sub>	0.0185	0.0268	Mole Fraction 0.2986
287.8 - 291.7	Heptadecanes	C <sub>17</sub>	0.0160	0.0247	Density (g/cc) 0.8780
291.7 - 317.2	Octadecanes	C <sub>18</sub>	0.0153	0.0251	
317.2 - 330	Nonadecanes	C <sub>19</sub>	0.0137	0.0235	<b>C<sub>30+</sub> Fraction</b>
330 - 344.4	Eicosanes	C <sub>20</sub>	0.0110	0.0197	
344.4 - 357.2	Heneicosanes	C <sub>21</sub>	0.0095	0.0180	Molecular Weight 568.29
357.2 - 369.4	Docosanes	C <sub>22</sub>	0.0085	0.0169	Mole Fraction 0.0383
369.4 - 380	Tricosanes	C <sub>23</sub>	0.0075	0.0157	Density (g/cc) 0.9824
380 - 391.1	Tetracosanes	C <sub>24</sub>	0.0066	0.0143	
391.1 - 401.7	Pentacosanes	C <sub>25</sub>	0.0061	0.0137	
401.7 - 412.2	Hexacosanes	C <sub>26</sub>	0.0053	0.0124	
412.3 - 422.2	Heptacosanes	C <sub>27</sub>	0.0046	0.0112	
422.3 - 431.7	Octacosanes	C <sub>28</sub>	0.0042	0.0107	
431.7 - 441.1	Nonacosanes	C <sub>29</sub>	0.0037	0.0098	
Above 441.1	Tricontanes Plus	C <sub>30+</sub>	0.0383	0.1422	
	<b>NAPHTHENES</b>				
48.9	Cyclopentane	C <sub>5</sub> H <sub>10</sub>	0.0037	0.0017	
72.2	Methylcyclopentane	C <sub>6</sub> H <sub>12</sub>	0.0154	0.0085	
81.1	Cyclohexane	C <sub>6</sub> H <sub>12</sub>	0.0129	0.0071	
101.1	Methylcyclohexane	C <sub>7</sub> H <sub>14</sub>	0.0337	0.0216	
	<b>AROMATICICS</b>				
80.0	Benzene	C <sub>6</sub> H <sub>6</sub>	0.0020	0.0010	
110.6	Toluene	C <sub>7</sub> H <sub>8</sub>	0.0085	0.0051	
136.1 - 138.9	Ethylbenzene & p,m-Xyle	C <sub>8</sub> H <sub>10</sub>	0.0099	0.0069	
144.4	o-Xylene	C <sub>8</sub> H <sub>10</sub>	0.0079	0.0055	
168.9	1, 2, 4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	0.0148	0.0116	
<b>Total</b>			<b>1.0000</b>	<b>1.0000</b>	

Note: Physical Properties calculated based GPA 2145-00 physical constants

**TABLE A3  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF FLASHED GAS**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0127	0.0127		
Carbon Dioxide	CO <sub>2</sub>	0.0058	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.6455	0.6493		
Ethane	C <sub>2</sub>	0.1677	0.1687		
Propane	C <sub>3</sub>	0.1004	0.1010	65.554	368.055
i-Butane	i-C <sub>4</sub>	0.0148	0.0149	11.475	64.425
n-Butane	n-C <sub>4</sub>	0.0327	0.0329	24.461	137.337
i-Pentane	i-C <sub>5</sub>	0.0072	0.0072	6.259	35.140
n-Pentane	n-C <sub>5</sub>	0.0070	0.0071	6.036	33.888
Hexanes	C <sub>6</sub>	0.0041	0.0041	3.999	22.451
Heptanes	C <sub>7</sub>	0.0014	0.0014	1.572	8.826
Octanes	C <sub>8</sub>	0.0006	0.0006	0.732	4.109
Nonanes	C <sub>9</sub>	0.0001	0.0001	0.133	0.747
Decanes	C <sub>10</sub>	0.0000	0.0000	0.004	0.025
Undecane	C <sub>11</sub>	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C <sub>12+</sub>	0.0000	0.0000	0.000	0.000
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>120.225</b>	<b>675.004</b>
Propanes Plus	C <sub>3+</sub>	0.1683	0.1693	120.225	675.004
Butanes Plus	C <sub>4+</sub>	0.0679	0.0683	54.671	306.948
	C <sub>5+</sub>	0.0205	0.0206	18.735	105.186

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	24.79 kg/kmol	24.79 lb/lb-mol	Ppc	659.5 psia	4.55 MPa
Specific Gravity	0.8559 (Air = 1)	0.8559 (Air = 1)	Tpc	440.2 R	244.5 K
MW of C7+	0.21 kg/kmol	0.21 lb/lbmol	Ppc*	657.8 psia	4.54 MPa
Density of C7+	0.7305 g/cc	730.5 kg/m3	Tpc*	439.0 R	243.9 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,444.7 Btu/scf	53.93 MJ/m3	Dry	1,315.6 Btu/scf	49.11 MJ/m3
Wet	1,419.5 Btu/scf	52.99 MJ/m3	Wet	1,292.7 Btu/scf	48.25 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150401

## **Appendix B**

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### **DIFFERENTIAL LIBERATION-MATERIAL BALANCE**

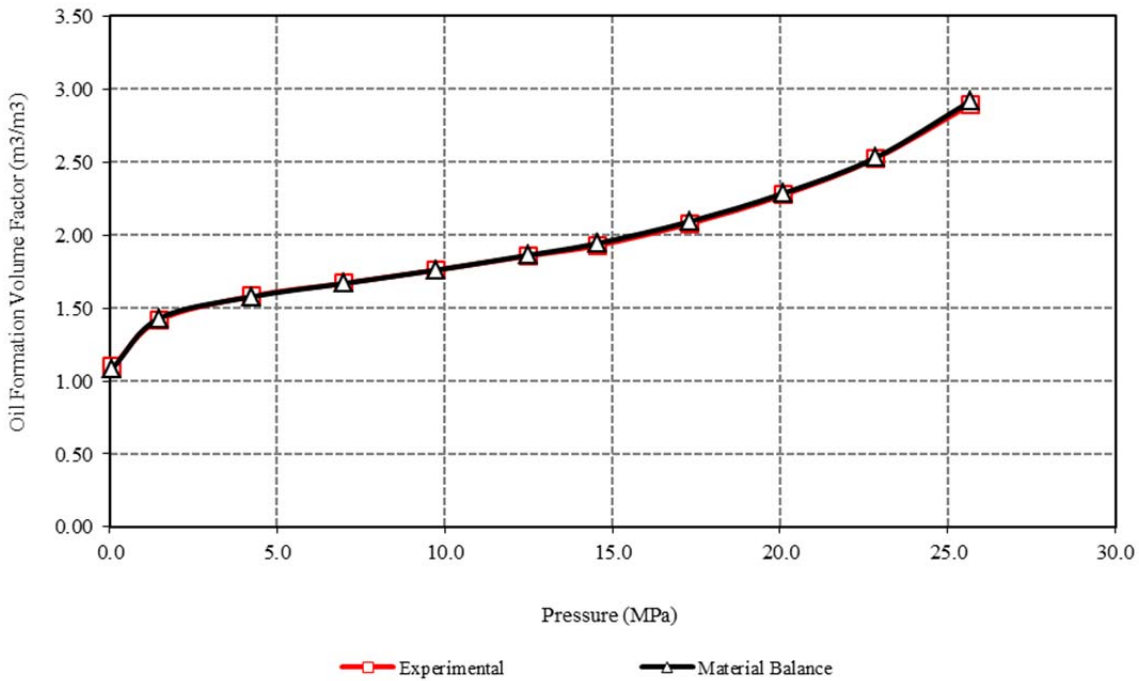
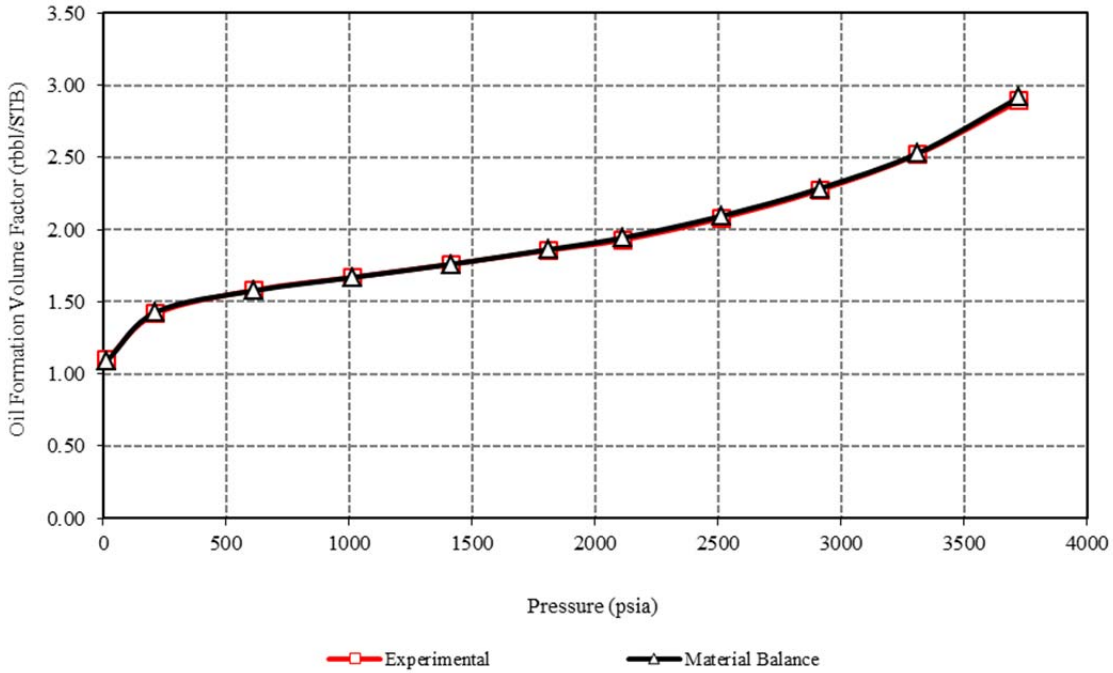
**TABLE B1  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION @ 229.7 °F (109.8 °C) - MATERIAL BALANCE**

Pressure		Measured Oil FVF [1]	Calculated Oil FVF [1]	Absolute Relative Error (%)
(psia)	(MPa)			
<b>3724 Psat</b>	<b>25.67</b>	<b>2.8942</b>	<b>2.9177</b>	<b>0.8055</b>
3313	22.84	2.5250	2.5309	0.2352
2913	20.08	2.2746	2.2860	0.4989
2513	17.33	2.0801	2.0946	0.6939
2113	14.57	1.9298	1.9442	0.7395
1813	12.50	1.8585	1.8630	0.2399
1413	9.74	1.7608	1.7609	0.0020
1013	6.98	1.6701	1.6689	0.0685
613	4.23	1.5822	1.5778	0.2815
213	1.47	1.4167	1.4289	0.8532
13	0.09	1.0975	1.0879	0.8828

[1] (res bbl/STB) (res m3/m3)  
 Psat - Saturation Pressure  
 - Tank conditions: 60 F (288.7 K) @ 13 psia (0.09 MPa)



**FIGURE B1**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE**  
**RESERVOIR FLUID STUDY**  
**DIFFERENTIAL LIBERATION @ 229.7 °F (109.8 °C) - MATERIAL BALANCE**



## Appendix C

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### DIFFERENTIAL LIBERATION -LIBERATED GAS COMPOSITIONS

**TABLE C1  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 3313 PSIA (22.84 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0152	0.0153		
Carbon Dioxide	CO <sub>2</sub>	0.0045	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.6859	0.6889		
Ethane	C <sub>2</sub>	0.1361	0.1367		
Propane	C <sub>3</sub>	0.0744	0.0748	48.604	272.889
i-Butane	i-C <sub>4</sub>	0.0116	0.0116	8.987	50.458
n-Butane	n-C <sub>4</sub>	0.0273	0.0274	20.388	114.467
i-Pentane	i-C <sub>5</sub>	0.0078	0.0078	6.771	38.013
n-Pentane	n-C <sub>5</sub>	0.0085	0.0086	7.322	41.112
Hexanes	C <sub>6</sub>	0.0095	0.0096	9.308	52.258
Heptanes	C <sub>7</sub>	0.0076	0.0077	8.370	46.992
Octanes	C <sub>8</sub>	0.0054	0.0055	6.594	37.023
Nonanes	C <sub>9</sub>	0.0020	0.0020	2.674	15.011
Decanes	C <sub>10</sub>	0.0011	0.0011	1.625	9.126
Undecane	C <sub>11</sub>	0.0005	0.0005	0.773	4.340
Dodecanes Plus	C <sub>12+</sub>	0.0026	0.0026	4.457	25.025
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>125.873</b>	<b>706.713</b>
Propanes Plus	C <sub>3+</sub>	0.1584	0.1591	125.873	706.713
Butanes Plus	C <sub>4+</sub>	0.0840	0.0843	77.268	433.823
	C <sub>5+</sub>	0.0451	0.0453	47.894	268.899

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	25.45 kg/kmol	25.45 lb/lb-mol	Ppc	652.7 psia	4.50 MPa
Specific Gravity	0.8788 (Air = 1)	0.8788 (Air = 1)	Tpc	437.4 R	243.0 K
MW of C7+	114.01 kg/kmol	114.01 lb/lbmol	Ppc*	651.4 psia	4.49 MPa
Density of C7+	0.7484 g/cc	748.4 kg/m3	Tpc*	436.5 R	242.5 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,481.4 Btu/scf	55.30 MJ/m3	Dry	1,350.1 Btu/scf	50.39 MJ/m3
Wet	1,455.6 Btu/scf	54.33 MJ/m3	Wet	1,326.6 Btu/scf	49.52 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150621

**TABLE C2  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 2913 PSIA (20.08 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0154	0.0155		
Carbon Dioxide	CO <sub>2</sub>	0.0047	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.6952	0.6985		
Ethane	C <sub>2</sub>	0.1373	0.1380		
Propane	C <sub>3</sub>	0.0714	0.0717	46.603	261.653
i-Butane	i-C <sub>4</sub>	0.0109	0.0110	8.468	47.542
n-Butane	n-C <sub>4</sub>	0.0255	0.0256	19.050	106.956
i-Pentane	i-C <sub>5</sub>	0.0075	0.0076	6.539	36.713
n-Pentane	n-C <sub>5</sub>	0.0084	0.0085	7.240	40.650
Hexanes	C <sub>6</sub>	0.0083	0.0084	8.136	45.680
Heptanes	C <sub>7</sub>	0.0062	0.0063	6.824	38.314
Octanes	C <sub>8</sub>	0.0043	0.0043	5.231	29.367
Nonanes	C <sub>9</sub>	0.0018	0.0018	2.428	13.634
Decanes	C <sub>10</sub>	0.0010	0.0010	1.510	8.476
Undecane	C <sub>11</sub>	0.0005	0.0005	0.806	4.527
Dodecanes Plus	C <sub>12+</sub>	0.0014	0.0014	2.412	13.542
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>115.247</b>	<b>647.053</b>
Propanes Plus	C <sub>3+</sub>	0.1473	0.1480	115.247	647.053
Butanes Plus	C <sub>4+</sub>	0.0760	0.0763	68.644	385.400
	C <sub>5+</sub>	0.0396	0.0398	41.126	230.903

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	24.77 kg/kmol	24.77 lb/lb-mol	Ppc	654.9 psia	4.52 MPa
Specific Gravity	0.8553 (Air = 1)	0.8553 (Air = 1)	Tpc	432.0 R	240.0 K
MW of C7+	112.35 kg/kmol	112.35 lb/lbmol	Ppc*	653.4 psia	4.51 MPa
Density of C7+	0.7467 g/cc	746.7 kg/m3	Tpc*	431.0 R	239.5 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,442.8 Btu/scf	53.86 MJ/m3	Dry	1,314.1 Btu/scf	49.05 MJ/m3
Wet	1,417.7 Btu/scf	52.92 MJ/m3	Wet	1,291.2 Btu/scf	48.20 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150623

**TABLE C3  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 2513 PSIA (17.33 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0153	0.0154		
Carbon Dioxide	CO <sub>2</sub>	0.0050	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.7002	0.7037		
Ethane	C <sub>2</sub>	0.1380	0.1387		
Propane	C <sub>3</sub>	0.0700	0.0704	45.722	256.707
i-Butane	i-C <sub>4</sub>	0.0106	0.0106	8.201	46.047
n-Butane	n-C <sub>4</sub>	0.0244	0.0245	18.264	102.543
i-Pentane	i-C <sub>5</sub>	0.0070	0.0070	6.051	33.971
n-Pentane	n-C <sub>5</sub>	0.0079	0.0080	6.830	38.344
Hexanes	C <sub>6</sub>	0.0079	0.0080	7.754	43.533
Heptanes	C <sub>7</sub>	0.0060	0.0060	6.551	36.782
Octanes	C <sub>8</sub>	0.0038	0.0038	4.583	25.730
Nonanes	C <sub>9</sub>	0.0016	0.0016	2.138	12.003
Decanes	C <sub>10</sub>	0.0009	0.0009	1.316	7.389
Undecane	C <sub>11</sub>	0.0004	0.0004	0.555	3.116
Dodecanes Plus	C <sub>12+</sub>	0.0010	0.0010	1.769	9.935
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>109.734</b>	<b>616.100</b>
Propanes Plus	C <sub>3+</sub>	0.1415	0.1422	109.734	616.100
Butanes Plus	C <sub>4+</sub>	0.0715	0.0718	64.011	359.393
	C <sub>5+</sub>	0.0365	0.0367	37.546	210.802

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	24.42 kg/kmol	24.42 lb/lb-mol	Ppc	656.1 psia	4.52 MPa
Specific Gravity	0.8433 (Air = 1)	0.8433 (Air = 1)	Tpc	429.2 R	238.4 K
MW of C7+	110.75 kg/kmol	110.75 lb/lbmol	Ppc*	654.6 psia	4.51 MPa
Density of C7+	0.7447 g/cc	744.7 kg/m3	Tpc*	428.2 R	237.9 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,423.4 Btu/scf	53.13 MJ/m3	Dry	1,295.9 Btu/scf	48.37 MJ/m3
Wet	1,398.6 Btu/scf	52.21 MJ/m3	Wet	1,273.4 Btu/scf	47.53 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150628

**TABLE C4  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 2113 PSIA (14.57 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0143	0.0144		
Carbon Dioxide	CO <sub>2</sub>	0.0052	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.7064	0.7101		
Ethane	C <sub>2</sub>	0.1410	0.1417		
Propane	C <sub>3</sub>	0.0697	0.0700	45.486	255.382
i-Butane	i-C <sub>4</sub>	0.0100	0.0100	7.732	43.410
n-Butane	n-C <sub>4</sub>	0.0229	0.0230	17.119	96.115
i-Pentane	i-C <sub>5</sub>	0.0063	0.0063	5.475	30.739
n-Pentane	n-C <sub>5</sub>	0.0069	0.0069	5.939	33.344
Hexanes	C <sub>6</sub>	0.0064	0.0065	6.289	35.308
Heptanes	C <sub>7</sub>	0.0048	0.0048	5.219	29.300
Octanes	C <sub>8</sub>	0.0035	0.0035	4.275	24.002
Nonanes	C <sub>9</sub>	0.0012	0.0012	1.604	9.006
Decanes	C <sub>10</sub>	0.0006	0.0006	0.874	4.905
Undecane	C <sub>11</sub>	0.0003	0.0003	0.440	2.471
Dodecanes Plus	C <sub>12+</sub>	0.0006	0.0006	1.072	6.021
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>101.523</b>	<b>570.004</b>
Propanes Plus	C <sub>3+</sub>	0.1331	0.1338	101.523	570.004
Butanes Plus	C <sub>4+</sub>	0.0635	0.0638	56.037	314.622
	C <sub>5+</sub>	0.0306	0.0308	31.186	175.097

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	23.89 kg/kmol	23.89 lb/lb-mol	Ppc	658.3 psia	4.54 MPa
Specific Gravity	0.8249 (Air = 1)	0.8249 (Air = 1)	Tpc	425.4 R	236.3 K
MW of C7+	109.34 kg/kmol	109.34 lb/lbmol	Ppc*	656.7 psia	4.53 MPa
Density of C7+	0.7432 g/cc	743.2 kg/m3	Tpc*	424.4 R	235.8 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,396.0 Btu/scf	52.11 MJ/m3	Dry	1,270.3 Btu/scf	47.42 MJ/m3
Wet	1,371.7 Btu/scf	51.20 MJ/m3	Wet	1,248.2 Btu/scf	46.59 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150635

**TABLE C5  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 1813 PSIA (12.50 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0129	0.0129		
Carbon Dioxide	CO <sub>2</sub>	0.0055	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.7041	0.7080		
Ethane	C <sub>2</sub>	0.1454	0.1462		
Propane	C <sub>3</sub>	0.0710	0.0714	46.376	260.380
i-Butane	i-C <sub>4</sub>	0.0101	0.0101	7.811	43.856
n-Butane	n-C <sub>4</sub>	0.0229	0.0230	17.118	96.108
i-Pentane	i-C <sub>5</sub>	0.0062	0.0062	5.385	30.237
n-Pentane	n-C <sub>5</sub>	0.0068	0.0069	5.874	32.981
Hexanes	C <sub>6</sub>	0.0063	0.0064	6.167	34.626
Heptanes	C <sub>7</sub>	0.0045	0.0045	4.914	27.592
Octanes	C <sub>8</sub>	0.0025	0.0025	2.991	16.795
Nonanes	C <sub>9</sub>	0.0009	0.0009	1.138	6.390
Decanes	C <sub>10</sub>	0.0005	0.0005	0.716	4.023
Undecane	C <sub>11</sub>	0.0002	0.0002	0.246	1.382
Dodecanes Plus	C <sub>12+</sub>	0.0003	0.0003	0.531	2.979
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>99.269</b>	<b>557.349</b>
Propanes Plus	C <sub>3+</sub>	0.1321	0.1328	99.269	557.349
Butanes Plus	C <sub>4+</sub>	0.0611	0.0614	52.893	296.969
	C <sub>5+</sub>	0.0281	0.0283	27.964	157.005

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	23.74 kg/kmol	23.74 lb/lb-mol	Ppc	659.5 psia	4.55 MPa
Specific Gravity	0.8196 (Air = 1)	0.8196 (Air = 1)	Tpc	425.2 R	236.2 K
MW of C7+	106.88 kg/kmol	106.88 lb/lbmol	Ppc*	657.8 psia	4.54 MPa
Density of C7+	0.7397 g/cc	739.7 kg/m3	Tpc*	424.2 R	235.6 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,389.3 Btu/scf	51.86 MJ/m3	Dry	1,264.0 Btu/scf	47.18 MJ/m3
Wet	1,365.1 Btu/scf	50.96 MJ/m3	Wet	1,242.0 Btu/scf	46.36 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150638

**TABLE C6  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 1413 PSIA (9.74 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0110	0.0110		
Carbon Dioxide	CO <sub>2</sub>	0.0059	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.6894	0.6935		
Ethane	C <sub>2</sub>	0.1548	0.1557		
Propane	C <sub>3</sub>	0.0756	0.0760	49.358	277.123
i-Butane	i-C <sub>4</sub>	0.0105	0.0105	8.137	45.684
n-Butane	n-C <sub>4</sub>	0.0237	0.0238	17.710	99.431
i-Pentane	i-C <sub>5</sub>	0.0062	0.0063	5.407	30.355
n-Pentane	n-C <sub>5</sub>	0.0068	0.0069	5.873	32.977
Hexanes	C <sub>6</sub>	0.0063	0.0063	6.145	34.502
Heptanes	C <sub>7</sub>	0.0046	0.0046	5.050	28.356
Octanes	C <sub>8</sub>	0.0032	0.0032	3.892	21.851
Nonanes	C <sub>9</sub>	0.0010	0.0010	1.332	7.479
Decanes	C <sub>10</sub>	0.0005	0.0005	0.729	4.093
Undecane	C <sub>11</sub>	0.0002	0.0002	0.346	1.945
Dodecanes Plus	C <sub>12+</sub>	0.0004	0.0004	0.609	3.421
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>104.589</b>	<b>587.215</b>
Propanes Plus	C <sub>3+</sub>	0.1390	0.1398	104.589	587.215
Butanes Plus	C <sub>4+</sub>	0.0634	0.0638	55.231	310.092
	C <sub>5+</sub>	0.0292	0.0294	29.384	164.977

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	24.15 kg/kmol	24.15 lb/lb-mol	Ppc	659.6 psia	4.55 MPa
Specific Gravity	0.8337 (Air = 1)	0.8337 (Air = 1)	Tpc	430.2 R	239.0 K
MW of C7+	107.49 kg/kmol	107.49 lb/lbmol	Ppc*	657.9 psia	4.54 MPa
Density of C7+	0.7408 g/cc	740.8 kg/m3	Tpc*	429.1 R	238.4 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,413.4 Btu/scf	52.76 MJ/m3	Dry	1,286.4 Btu/scf	48.02 MJ/m3
Wet	1,388.8 Btu/scf	51.84 MJ/m3	Wet	1,264.0 Btu/scf	47.18 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150640



**TABLE C7  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 1013 PSIA (6.98 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0087	0.0088		
Carbon Dioxide	CO <sub>2</sub>	0.0064	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.6602	0.6644		
Ethane	C <sub>2</sub>	0.1714	0.1725		
Propane	C <sub>3</sub>	0.0857	0.0863	55.991	314.363
i-Butane	i-C <sub>4</sub>	0.0117	0.0118	9.094	51.060
n-Butane	n-C <sub>4</sub>	0.0263	0.0265	19.666	110.417
i-Pentane	i-C <sub>5</sub>	0.0067	0.0067	5.796	32.539
n-Pentane	n-C <sub>5</sub>	0.0072	0.0073	6.227	34.961
Hexanes	C <sub>6</sub>	0.0064	0.0064	6.209	34.862
Heptanes	C <sub>7</sub>	0.0046	0.0046	5.013	28.145
Octanes	C <sub>8</sub>	0.0028	0.0029	3.457	19.410
Nonanes	C <sub>9</sub>	0.0010	0.0010	1.368	7.678
Decanes	C <sub>10</sub>	0.0005	0.0005	0.734	4.121
Undecane	C <sub>11</sub>	0.0002	0.0002	0.263	1.479
Dodecanes Plus	C <sub>12+</sub>	0.0002	0.0002	0.319	1.791
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>114.138</b>	<b>640.827</b>
Propanes Plus	C <sub>3+</sub>	0.1533	0.1543	114.138	640.827
Butanes Plus	C <sub>4+</sub>	0.0676	0.0680	58.146	326.464
	C <sub>5+</sub>	0.0296	0.0298	29.386	164.986

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	24.80 kg/kmol	24.80 lb/lb-mol	Ppc	659.9 psia	4.55 MPa
Specific Gravity	0.8563 (Air = 1)	0.8563 (Air = 1)	Tpc	438.9 R	243.8 K
MW of C7+	106.39 kg/kmol	106.39 lb/lbmol	Ppc*	658.0 psia	4.54 MPa
Density of C7+	0.7395 g/cc	739.5 kg/m3	Tpc*	437.7 R	243.2 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,450.9 Btu/scf	54.16 MJ/m3	Dry	1,321.4 Btu/scf	49.32 MJ/m3
Wet	1,425.6 Btu/scf	53.21 MJ/m3	Wet	1,298.4 Btu/scf	48.46 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150641

**TABLE C8  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 613 PSIA (4.23 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0059	0.0059		
Carbon Dioxide	CO <sub>2</sub>	0.0072	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.5893	0.5936		
Ethane	C <sub>2</sub>	0.2031	0.2046		
Propane	C <sub>3</sub>	0.1103	0.1111	72.011	404.304
i-Butane	i-C <sub>4</sub>	0.0152	0.0154	11.832	66.428
n-Butane	n-C <sub>4</sub>	0.0339	0.0342	25.400	142.607
i-Pentane	i-C <sub>5</sub>	0.0083	0.0083	7.196	40.404
n-Pentane	n-C <sub>5</sub>	0.0088	0.0089	7.585	42.588
Hexanes	C <sub>6</sub>	0.0072	0.0073	7.029	39.464
Heptanes	C <sub>7</sub>	0.0050	0.0050	5.443	30.562
Octanes	C <sub>8</sub>	0.0035	0.0035	4.201	23.588
Nonanes	C <sub>9</sub>	0.0015	0.0015	1.943	10.912
Decanes	C <sub>10</sub>	0.0005	0.0005	0.762	4.280
Undecane	C <sub>11</sub>	0.0001	0.0001	0.183	1.028
Dodecanes Plus	C <sub>12+</sub>	0.0002	0.0002	0.394	2.214
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>143.980</b>	<b>808.379</b>
Propanes Plus	C <sub>3+</sub>	0.1945	0.1959	143.980	808.379
Butanes Plus	C <sub>4+</sub>	0.0843	0.0849	71.970	404.075
	C <sub>5+</sub>	0.0351	0.0353	34.738	195.040

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	26.77 kg/kmol	26.77 lb/lb-mol	Ppc	658.1 psia	4.54 MPa
Specific Gravity	0.9241 (Air = 1)	0.9241 (Air = 1)	Tpc	461.5 R	256.4 K
MW of C7+	106.72 kg/kmol	106.72 lb/lbmol	Ppc*	656.2 psia	4.52 MPa
Density of C7+	0.7402 g/cc	740.2 kg/m3	Tpc*	460.2 R	255.7 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,558.9 Btu/scf	58.19 MJ/m3	Dry	1,422.1 Btu/scf	53.08 MJ/m3
Wet	1,531.7 Btu/scf	57.18 MJ/m3	Wet	1,397.4 Btu/scf	52.16 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150642

**TABLE C9  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 213 PSIA (1.47 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0022	0.0022		
Carbon Dioxide	CO <sub>2</sub>	0.0075	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.3768	0.3797		
Ethane	C <sub>2</sub>	0.2471	0.2489		
Propane	C <sub>3</sub>	0.1962	0.1977	128.138	719.431
i-Butane	i-C <sub>4</sub>	0.0300	0.0302	23.289	130.756
n-Butane	n-C <sub>4</sub>	0.0653	0.0658	48.839	274.207
i-Pentane	i-C <sub>5</sub>	0.0178	0.0180	15.502	87.037
n-Pentane	n-C <sub>5</sub>	0.0178	0.0180	15.326	86.048
Hexanes	C <sub>6</sub>	0.0152	0.0153	14.840	83.320
Heptanes	C <sub>7</sub>	0.0107	0.0108	11.725	65.830
Octanes	C <sub>8</sub>	0.0081	0.0082	9.854	55.323
Nonanes	C <sub>9</sub>	0.0034	0.0034	4.478	25.143
Decanes	C <sub>10</sub>	0.0015	0.0016	2.245	12.605
Undecane	C <sub>11</sub>	0.0001	0.0001	0.096	0.540
Dodecanes Plus	C <sub>12+</sub>	0.0002	0.0002	0.341	1.913
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>274.673</b>	<b>1542.154</b>
Propanes Plus	C <sub>3+</sub>	0.3663	0.3691	274.673	1542.154
Butanes Plus	C <sub>4+</sub>	0.1701	0.1714	146.535	822.723
	C <sub>5+</sub>	0.0748	0.0754	74.407	417.759

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	34.49 kg/kmol	34.49 lb/lb-mol	Ppc	641.5 psia	4.42 MPa
Specific Gravity	1.1908 (Air = 1)	1.1908 (Air = 1)	Tpc	540.5 R	300.3 K
MW of C7+	106.33 kg/kmol	106.33 lb/lbmol	Ppc*	639.8 psia	4.41 MPa
Density of C7+	0.7401 g/cc	740.1 kg/m3	Tpc*	539.1 R	299.5 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,978.7 Btu/scf	73.86 MJ/m3	Dry	1,814.0 Btu/scf	67.71 MJ/m3
Wet	1,944.3 Btu/scf	72.57 MJ/m3	Wet	1,782.4 Btu/scf	66.53 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150644

**TABLE C9  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
DIFFERENTIAL LIBERATION GAS @ 13 PSIA (0.09 MPa)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0004	0.0004		
Carbon Dioxide	CO <sub>2</sub>	0.0024	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.1309	0.1313		
Ethane	C <sub>2</sub>	0.1060	0.1063		
Propane	C <sub>3</sub>	0.1653	0.1657	107.918	605.909
i-Butane	i-C <sub>4</sub>	0.0415	0.0416	32.241	181.016
n-Butane	n-C <sub>4</sub>	0.1172	0.1175	87.669	492.220
i-Pentane	i-C <sub>5</sub>	0.0520	0.0522	45.241	254.007
n-Pentane	n-C <sub>5</sub>	0.0629	0.0631	54.063	303.539
Hexanes	C <sub>6</sub>	0.0854	0.0856	83.387	468.179
Heptanes	C <sub>7</sub>	0.0960	0.0963	105.137	590.291
Octanes	C <sub>8</sub>	0.0922	0.0924	112.073	629.237
Nonanes	C <sub>9</sub>	0.0250	0.0251	33.398	187.513
Decanes	C <sub>10</sub>	0.0165	0.0165	23.999	134.742
Undecane	C <sub>11</sub>	0.0055	0.0055	8.633	48.471
Dodecanes Plus	C <sub>12+</sub>	0.0007	0.0007	1.247	7.001
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>695.008</b>	<b>3902.125</b>
Propanes Plus	C <sub>3+</sub>	0.7603	0.7621	695.008	3902.125
Butanes Plus	C <sub>4+</sub>	0.5950	0.5964	587.089	3296.217
	C <sub>5+</sub>	0.4363	0.4373	467.179	2622.980

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	62.81 kg/kmol	62.81 lb/lb-mol	Ppc	534.7 psia	3.69 MPa
Specific Gravity	2.1686 (Air = 1)	2.1686 (Air = 1)	Tpc	750.3 R	416.8 K
MW of C7+	106.98 kg/kmol	106.98 lb/lbmol	Ppc*	534.3 psia	3.68 MPa
Density of C7+	0.7411 g/cc	741.1 kg/m3	Tpc*	749.8 R	416.6 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	3,535.7 Btu/scf	131.98 MJ/m3	Dry	3,268.8 Btu/scf	122.02 MJ/m3
Wet	3,474.2 Btu/scf	129.68 MJ/m3	Wet	3,211.9 Btu/scf	119.89 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150645

## Appendix D

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### MULTI-STAGE SEPARATOR TEST-MATERIAL BALANCE

**TABLE D1  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
SEPARATOR TEST - MATERIAL BALANCE**

Pressure		Measured Oil FVF [1]	Calculated Oil FVF [1]	Absolute Relative Error (%)
(psia)	(MPa)			
<b>3724 Psat</b>	<b>25.67</b>	<b>2.1783</b>	<b>2.1960</b>	<b>0.8050</b>
688	4.74	1.2695	1.2700	0.0430
187	1.29	1.1523	1.1600	0.6684
13	0.09	1.0000	1.0000	0.0018

[1] (res bbl/STB) (res m<sup>3</sup>/m<sup>3</sup>)  
 Psat - Saturation Pressure  
 - Tank conditions: 60 F (288.7 K) @ 13 psia (0.09 MPa)

## Appendix E

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### MULTI-STAGE SEPARATOR TEST -LIBERATED GAS COMPOSITIONS

**TABLE E1  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
MULTI-STAGE SEPARATOR GAS @ 688 PSIA (4.74 MPa) & 114.8°F (46.0°C)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0139	0.0140		
Carbon Dioxide	CO <sub>2</sub>	0.0057	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.7579	0.7623		
Ethane	C <sub>2</sub>	0.1403	0.1411		
Propane	C <sub>3</sub>	0.0548	0.0551	35.767	200.813
i-Butane	i-C <sub>4</sub>	0.0062	0.0062	4.803	26.966
n-Butane	n-C <sub>4</sub>	0.0123	0.0124	9.198	51.641
i-Pentane	i-C <sub>5</sub>	0.0024	0.0025	2.119	11.895
n-Pentane	n-C <sub>5</sub>	0.0024	0.0024	2.088	11.721
Hexanes	C <sub>6</sub>	0.0016	0.0016	1.539	8.638
Heptanes	C <sub>7</sub>	0.0012	0.0012	1.294	7.268
Octanes	C <sub>8</sub>	0.0009	0.0010	1.151	6.461
Nonanes	C <sub>9</sub>	0.0003	0.0003	0.452	2.540
Decanes	C <sub>10</sub>	0.0000	0.0000	0.006	0.034
Undecane	C <sub>11</sub>	0.0000	0.0000	0.000	0.002
Dodecanes Plus	C <sub>12+</sub>	0.0000	0.0000	0.000	0.000
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>58.416</b>	<b>327.979</b>
Propanes Plus	C <sub>3+</sub>	0.0822	0.0826	58.416	327.979
Butanes Plus	C <sub>4+</sub>	0.0274	0.0276	22.649	127.166
Pentanes Plus	C <sub>5+</sub>	0.0089	0.0090	8.649	48.558

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	21.25 kg/kmol	21.25 lb/lb-mol	Ppc	666.2 psia	4.59 MPa
Specific Gravity	0.7337 (Air = 1)	0.7337 (Air = 1)	Tpc	401.8 R	223.2 K
MW of C7+	103.71 kg/kmol	103.71 lb/lbmol	Ppc*	664.4 psia	4.58 MPa
Density of C7+	0.7367 g/cc	736.7 kg/m3	Tpc*	400.7 R	222.6 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,252.9 Btu/scf	46.77 MJ/m3	Dry	1,136.7 Btu/scf	42.43 MJ/m3
Wet	1,231.1 Btu/scf	45.95 MJ/m3	Wet	1,116.9 Btu/scf	41.69 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150690



**TABLE E2  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
MULTI-STAGE SEPARATOR GAS @ 187 PSIA (1.29 MPa) & 59.0°F (15.0°C)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0055	0.0056		
Carbon Dioxide	CO <sub>2</sub>	0.0073	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.6791	0.6841		
Ethane	C <sub>2</sub>	0.2029	0.2044		
Propane	C <sub>3</sub>	0.0761	0.0766	49.682	278.942
i-Butane	i-C <sub>4</sub>	0.0075	0.0075	5.814	32.643
n-Butane	n-C <sub>4</sub>	0.0137	0.0138	10.245	57.519
i-Pentane	i-C <sub>5</sub>	0.0023	0.0023	2.019	11.333
n-Pentane	n-C <sub>5</sub>	0.0022	0.0022	1.887	10.595
Hexanes	C <sub>6</sub>	0.0013	0.0013	1.259	7.069
Heptanes	C <sub>7</sub>	0.0010	0.0010	1.073	6.027
Octanes	C <sub>8</sub>	0.0008	0.0008	0.975	5.476
Nonanes	C <sub>9</sub>	0.0003	0.0003	0.415	2.331
Decanes	C <sub>10</sub>	0.0000	0.0000	0.000	0.000
Undecane	C <sub>11</sub>	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C <sub>12+</sub>	0.0000	0.0000	0.000	0.000
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>73.370</b>	<b>411.935</b>
Propanes Plus	C <sub>3+</sub>	0.1052	0.1059	73.370	411.935
Butanes Plus	C <sub>4+</sub>	0.0291	0.0293	23.687	132.992
Pentanes Plus	C <sub>5+</sub>	0.0079	0.0080	7.629	42.831

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	22.71 kg/kmol	22.71 lb/lb-mol	Ppc	669.6 psia	4.62 MPa
Specific Gravity	0.7842 (Air = 1)	0.7842 (Air = 1)	Tpc	423.5 R	235.3 K
MW of C7+	103.93 kg/kmol	103.93 lb/lbmol	Ppc*	667.4 psia	4.60 MPa
Density of C7+	0.7370 g/cc	737.0 kg/m3	Tpc*	422.1 R	234.5 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,341.5 Btu/scf	50.08 MJ/m3	Dry	1,219.2 Btu/scf	45.51 MJ/m3
Wet	1,318.2 Btu/scf	49.20 MJ/m3	Wet	1,198.0 Btu/scf	44.72 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150694

**TABLE E3  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – RECOMBINED SAMPLE  
RESERVOIR FLUID STUDY  
MULTI-STAGE SEPARATOR GAS @ 13 PSIA (0.09 MPa) & 60.0°F (15.6°C)**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0005	0.0005		
Carbon Dioxide	CO <sub>2</sub>	0.0065	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.1999	0.2012		
Ethane	C <sub>2</sub>	0.2839	0.2857		
Propane	C <sub>3</sub>	0.3241	0.3262	211.640	1188.257
i-Butane	i-C <sub>4</sub>	0.0451	0.0454	35.013	196.582
n-Butane	n-C <sub>4</sub>	0.0869	0.0875	65.046	365.202
i-Pentane	i-C <sub>5</sub>	0.0201	0.0203	17.505	98.284
n-Pentane	n-C <sub>5</sub>	0.0190	0.0192	16.368	91.900
Hexanes	C <sub>6</sub>	0.0088	0.0089	8.593	48.243
Heptanes	C <sub>7</sub>	0.0032	0.0032	3.484	19.560
Octanes	C <sub>8</sub>	0.0018	0.0018	2.132	11.972
Nonanes	C <sub>9</sub>	0.0003	0.0003	0.348	1.952
Decanes	C <sub>10</sub>	0.0000	0.0000	0.000	0.000
Undecane	C <sub>11</sub>	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C <sub>12+</sub>	0.0000	0.0000	0.000	0.000
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>360.130</b>	<b>2021.952</b>
Propanes Plus	C <sub>3+</sub>	0.5093	0.5126	360.130	2021.952
Butanes Plus	C <sub>4+</sub>	0.1852	0.1864	148.489	833.695
Pentanes Plus	C <sub>5+</sub>	0.0532	0.0535	48.430	271.911

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	38.12 kg/kmol	38.12 lb/lb-mol	Ppc	638.1 psia	4.40 MPa
Specific Gravity	1.3160 (Air = 1)	1.3160 (Air = 1)	Tpc	589.7 R	327.6 K
MW of C7+	100.97 kg/kmol	100.97 lb/lbmol	Ppc*	636.7 psia	4.39 MPa
Density of C7+	0.7319 g/cc	731.9 kg/m3	Tpc*	588.5 R	326.9 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	2,178.9 Btu/scf	81.33 MJ/m3	Dry	2,000.3 Btu/scf	74.67 MJ/m3
Wet	2,141.0 Btu/scf	79.92 MJ/m3	Wet	1,965.5 Btu/scf	73.37 MJ/m3

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC No.: A150695

## Appendix F

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### SELECTED SEPARATOR SAMPLES VALIDATION

**TABLE F1  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – SAMPLE HY 492  
RESERVOIR FLUID STUDY  
SEPARATOR GAS – SAMPLE COLLECTION DATA**

Project File:	CL-70073		
Company:	ENCANA CORPORATION		
Pool:	DUVERNAY		
Field:	KAYBOB		
Well Location:	4-12-64-23W5		
Fluid Sample:	HY492		
Sample Description:	SEP GAS-RATE 1		
Sampling Company:	WFT		
Name of Sampler:	BS		
Sampling Date:	16-Oct-14		
Sampling Point:	SEPARATOR		
Sampling Temperature:	114.8 F		46 C
Sampling Pressure:	675 psia		4.65 MPa
Reservoir Temperature:	229.7 F		109.8 C
Reservoir Pressure:	8241.0 psia		56.82 MPa
Initial Reservoir Pressure (Pi)	N/A psia		N/A MPa
Depth of Reported Pi	N/A mMD		N/A mss

**TABLE F2  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – SAMPLE HY 492  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF SEPARATOR GAS**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0136	0.0136		
Carbon Dioxide	CO <sub>2</sub>	0.0058	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.7426	0.7470		
Ethane	C <sub>2</sub>	0.1474	0.1482		
Propane	C <sub>3</sub>	0.0608	0.0611	39.686	222.816
i-Butane	i-C <sub>4</sub>	0.0070	0.0071	5.465	30.681
n-Butane	n-C <sub>4</sub>	0.0141	0.0141	10.519	59.060
i-Pentane	i-C <sub>5</sub>	0.0028	0.0029	2.464	13.834
n-Pentane	n-C <sub>5</sub>	0.0029	0.0029	2.480	13.922
Hexanes	C <sub>6</sub>	0.0017	0.0018	1.699	9.539
Heptanes	C <sub>7</sub>	0.0010	0.0010	1.122	6.302
Octanes	C <sub>8</sub>	0.0002	0.0002	0.198	1.109
Nonanes	C <sub>9</sub>	0.0001	0.0001	0.117	0.656
Decanes	C <sub>10</sub>	0.0000	0.0000	0.043	0.244
Undecane	C <sub>11</sub>	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C <sub>12+</sub>	0.0000	0.0000	0.000	0.000
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>63.792</b>	<b>358.163</b>
Propanes Plus	C <sub>3+</sub>	0.0906	0.0912	63.792	358.163
Butanes Plus	C <sub>4+</sub>	0.0299	0.0300	24.107	135.347
Pentanes Plus	C <sub>5+</sub>	0.0088	0.0088	8.123	45.605

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	21.58 kg/kmol	21.58 lb/lb-mol	Ppc	666.1 psia	4.59 MPa
Specific Gravity	0.7450 (Air = 1)	0.7450 (Air = 1)	Tpc	406.1 R	225.6 K
MW of C7+	99.91 kg/kmol	99.91 lb/lbmol	Ppc*	664.3 psia	4.58 MPa
Density of C7+	0.7290 g/cc	729.0 kg/m3	Tpc*	405.0 R	225.0 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,270.9 Btu/scf	47.44 MJ/m3	Dry	1,153.5 Btu/scf	43.06 MJ/m3
Wet	1,248.8 Btu/scf	46.61 MJ/m3	Wet	1,133.4 Btu/scf	42.31 MJ/m3

\* - Corrected for Acid Gas Content

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC ID: A141451

ID: 20240

**TABLE F3  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – SAMPLE W3A9234  
RESERVOIR FLUID STUDY  
SEPARATOR LIQUID – SAMPLE COLLECTION DATA**

Project File:	CL-70073		
Company:	ENCANA CORPORATION		
Pool:	DUVERNAY		
Field:	KAYBOB		
Well Location:	4-12-64-23W5		
Fluid Sample:	W3A9234		
Sample Description:	LIVE SEP OIL-RATE 1		
Sampling Company:	WFT		
Name of Sampler:	BS		
Sampling Date:	16-Oct-14		
Sampling Point:	SEPARATOR		
Sampling Temperature:	114.8 F		46 C
Sampling Pressure:	675 psia		4.65 MPa
Reservoir Temperature:	229.7 F		109.8 C
Reservoir Pressure:	8241.0 psia		56.82 MPa
Initial Reservoir Pressure (Pi)	N/A psia		N/A MPa
Depth of Reported Pi	N/A mMD		N/A mss

**TABLE F4**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – SAMPLE W3A9234**  
**RESERVOIR FLUID STUDY**  
**SEPARATOR LIQUID – SAMPLE VALIDATION DATA**

**INITIAL RESERVOIR CONDITIONS**

Reservoir Pressure	8241 psia	56.82 MPa
Reservoir Temperature:	229.7 F	109.8 C

**SINGLE-STAGE SEPARATOR TEST @ 1,563 psia (10.78 MPa) AND 158.0 F (343.2 K)**

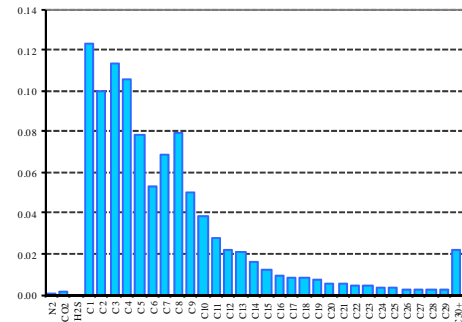
At Separator Test Conditions		
Oil Formation Volume Factor	1.3065 res.bbl/STB	1.3065 res.m <sup>3</sup> /m <sup>3</sup>
Solution Gas-Oil Ratio	459.59 scf/STB	81.85 m <sup>3</sup> /m <sup>3</sup>
Oil Density	0.6935 g/cm <sup>3</sup>	693.5 kg/m <sup>3</sup>
At Tank Conditions		
Residual Oil Density	0.7912 g/cm <sup>3</sup>	791.2 kg/m <sup>3</sup>
API Gravity	47.34	47.34

**SINGLE-STAGE SEPARATOR TEST - MATERIAL BALANCE CHECK**

Oil FVF @ 1563 psia (10.78 MPa) (Measured)	1.3065	res.bbl/STB (res.m <sup>3</sup> /m <sup>3</sup> )
Oil FVF @ 1563 psia (10.78 MPa) (Calculated)	1.3135	res.bbl/STB (res.m <sup>3</sup> /m <sup>3</sup> )
Absolute Relative Error	0.5339	(%)

**TABLE F5**  
**ENCANA CORPORATION**  
**WELL ECA HZ WAHIGAN 04-12-064-23W5 – SAMPLE W3A9234**  
**RESERVOIR FLUID STUDY**  
**COMPOSITIONAL ANALYSIS OF SEPARATOR FLUID**

Boiling Point (C)	Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties
-195.8	Nitrogen	N <sub>2</sub>	0.0008	0.0002	<b>Total Sample</b>
-78.5	Carbon Dioxide	CO <sub>2</sub>	0.0019	0.0008	
-60.3	Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000	Molecular Weight 101.55
-161.7	Methane	C <sub>1</sub>	0.1232	0.0195	
-88.9	Ethane	C <sub>2</sub>	0.0995	0.0295	
-42.2	Propane	C <sub>3</sub>	0.1136	0.0493	<b>C<sub>6+</sub> Fraction</b>
-11.7	i-Butane	i-C <sub>4</sub>	0.0278	0.0159	
-0.6	n-Butane	n-C <sub>4</sub>	0.0775	0.0444	Molecular Weight 166.85
27.8	i-Pentane	i-C <sub>5</sub>	0.0345	0.0245	Mole Fraction 0.4755
36.1	n-Pentane	n-C <sub>5</sub>	0.0434	0.0308	Density (g/cc) 0.8198
36.1 - 68.9	Hexanes	C <sub>6</sub>	0.0509	0.0432	
68.9 - 98.3	Heptanes	C <sub>7</sub>	0.0502	0.0495	<b>C<sub>7+</sub> Fraction</b>
98.3 - 125.6	Octanes	C <sub>8</sub>	0.0552	0.0621	
125.6 - 150.6	Nonanes	C <sub>9</sub>	0.0400	0.0505	Molecular Weight 176.80
150.6 - 173.9	Decanes	C <sub>10</sub>	0.0305	0.0428	Mole Fraction 0.4060
173.9 - 196.1	Undecanes	C <sub>11</sub>	0.0277	0.0401	Density (g/cc) 0.8295
196.1 - 215	Dodecanes	C <sub>12</sub>	0.0222	0.0352	
215 - 235	Tridecanes	C <sub>13</sub>	0.0208	0.0358	<b>C<sub>12+</sub> Fraction</b>
235 - 252.2	Tetradecanes	C <sub>14</sub>	0.0160	0.0299	
252.2 - 270.6	Pentadecanes	C <sub>15</sub>	0.0118	0.0239	Molecular Weight 277.22
270.6 - 287.8	Hexadecanes	C <sub>16</sub>	0.0094	0.0206	Mole Fraction 0.1600
287.8 - 291.7	Heptadecanes	C <sub>17</sub>	0.0081	0.0190	Density (g/cc) 0.8797
291.7 - 317.2	Octadecanes	C <sub>18</sub>	0.0079	0.0195	
317.2 - 330	Nonadecanes	C <sub>19</sub>	0.0070	0.0182	<b>C<sub>30+</sub> Fraction</b>
330 - 344.4	Eicosanes	C <sub>20</sub>	0.0056	0.0153	
344.4 - 357.2	Heneicosanes	C <sub>21</sub>	0.0050	0.0144	Molecular Weight 568.29
357.2 - 369.4	Docosanes	C <sub>22</sub>	0.0041	0.0125	Mole Fraction 0.0221
369.4 - 380	Tricosanes	C <sub>23</sub>	0.0039	0.0124	Density (g/cc) 0.9824
380 - 391.1	Tetracosanes	C <sub>24</sub>	0.0035	0.0113	
391.1 - 401.7	Pentacosanes	C <sub>25</sub>	0.0031	0.0105	
401.7 - 412.2	Hexacosanes	C <sub>26</sub>	0.0027	0.0096	<b>Recombination Parameters</b>
412.3 - 422.2	Heptacosanes	C <sub>27</sub>	0.0024	0.0087	
422.3 - 431.7	Octacosanes	C <sub>28</sub>	0.0022	0.0085	Gas-Oil Ratio (cc/cc) 81.85
431.7 - 441.1	Nonacosanes	C <sub>29</sub>	0.0020	0.0078	Dead Oil Density (g/cc) 0.7912
Above 441.1	Tricontanes Plus	C <sub>30+</sub>	0.0221	0.1235	Dead Oil MW (g/mol) 143.47
<b>NAPHTHENES</b>					
48.9	Cyclopentane	C <sub>5</sub> H <sub>10</sub>	0.0024	0.0016	
72.2	Methylcyclopentane	C <sub>6</sub> H <sub>12</sub>	0.0097	0.0080	
81.1	Cyclohexane	C <sub>6</sub> H <sub>12</sub>	0.0077	0.0064	
101.1	Methylcyclohexane	C <sub>7</sub> H <sub>14</sub>	0.0193	0.0187	
<b>AROMATICS</b>					
80.0	Benzene	C <sub>6</sub> H <sub>6</sub>	0.0012	0.0010	
110.6	Toluene	C <sub>7</sub> H <sub>8</sub>	0.0050	0.0046	
136.1 - 138.9	Ethylbenzene & p,m-Xyle	C <sub>8</sub> H <sub>10</sub>	0.0056	0.0059	
144.4	o-Xylene	C <sub>8</sub> H <sub>10</sub>	0.0044	0.0046	
168.9	1, 2, 4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	0.0080	0.0095	
<b>Total</b>			<b>1.0000</b>	<b>1.0000</b>	



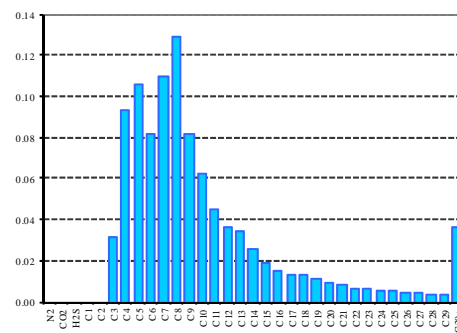
Note: Physical properties are calculated based on GPA 2145-00 physical constants

ID.: 8720-3388



**TABLE F6  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – SAMPLE W3A9234  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF FLASHED OIL**

Boiling Point (C)	Component Name	Chemical Symbol	Mole Fraction	Mass Fraction	Calculated Properties
-195.8	Nitrogen	N <sub>2</sub>	0.0000	0.0000	<b>Total Sample</b>
-78.5	Carbon Dioxide	CO <sub>2</sub>	0.0000	0.0000	
-60.3	Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000	Molecular Weight 143.47
-161.7	Methane	C <sub>1</sub>	0.0000	0.0000	Density (g/cc) 0.7897
-88.9	Ethane	C <sub>2</sub>	0.0000	0.0000	
-42.2	Propane	C <sub>3</sub>	0.0309	0.0095	<b>C<sub>6+</sub> Fraction</b>
-11.7	i-Butane	i-C <sub>4</sub>	0.0200	0.0081	
-0.6	n-Butane	n-C <sub>4</sub>	0.0729	0.0295	Molecular Weight 167.54
27.8	i-Pentane	i-C <sub>5</sub>	0.0453	0.0228	Mole Fraction 0.7705
36.1	n-Pentane	n-C <sub>5</sub>	0.0605	0.0304	Density (g/cc) 0.8205
36.1 - 68.9	Hexanes	C <sub>6</sub>	0.0780	0.0468	
68.9 - 98.3	Heptanes	C <sub>7</sub>	0.0802	0.0560	<b>C<sub>7+</sub> Fraction</b>
98.3 - 125.6	Octanes	C <sub>8</sub>	0.0897	0.0714	
125.6 - 150.6	Nonanes	C <sub>9</sub>	0.0650	0.0581	Molecular Weight 177.29
150.6 - 173.9	Decanes	C <sub>10</sub>	0.0497	0.0493	Mole Fraction 0.6887
173.9 - 196.1	Undecanes	C <sub>11</sub>	0.0451	0.0462	Density (g/cc) 0.8297
196.1 - 215	Dodecanes	C <sub>12</sub>	0.0361	0.0406	
215 - 235	Tridecanes	C <sub>13</sub>	0.0338	0.0412	<b>C<sub>12+</sub> Fraction</b>
235 - 252.2	Tetradecanes	C <sub>14</sub>	0.0260	0.0345	
252.2 - 270.6	Pentadecanes	C <sub>15</sub>	0.0192	0.0275	Molecular Weight 277.22
270.6 - 287.8	Hexadecanes	C <sub>16</sub>	0.0154	0.0238	Mole Fraction 0.2602
287.8 - 291.7	Heptadecanes	C <sub>17</sub>	0.0132	0.0218	Density (g/cc) 0.8797
291.7 - 317.2	Octadecanes	C <sub>18</sub>	0.0129	0.0225	
317.2 - 330	Nonadecanes	C <sub>19</sub>	0.0114	0.0209	<b>C<sub>30+</sub> Fraction</b>
330 - 344.4	Eicosanes	C <sub>20</sub>	0.0092	0.0176	
344.4 - 357.2	Heneicosanes	C <sub>21</sub>	0.0082	0.0165	Molecular Weight 568.29
357.2 - 369.4	Docosanes	C <sub>22</sub>	0.0067	0.0143	Mole Fraction 0.0359
369.4 - 380	Tricosanes	C <sub>23</sub>	0.0064	0.0142	Density (g/cc) 0.9824
380 - 391.1	Tetracosanes	C <sub>24</sub>	0.0057	0.0131	
391.1 - 401.7	Pentacosanes	C <sub>25</sub>	0.0050	0.0121	
401.7 - 412.2	Hexacosanes	C <sub>26</sub>	0.0044	0.0111	
412.3 - 422.2	Heptacosanes	C <sub>27</sub>	0.0039	0.0101	
422.3 - 431.7	Octacosanes	C <sub>28</sub>	0.0036	0.0098	
431.7 - 441.1	Nonacosanes	C <sub>29</sub>	0.0032	0.0090	
Above 441.1	Tricontanes Plus	C <sub>30+</sub>	0.0359	0.1422	
	<b>NAPHTHENES</b>				
48.9	Cyclopentane	C <sub>5</sub> H <sub>10</sub>	0.0038	0.0019	
72.2	Methylcyclopentane	C <sub>6</sub> H <sub>12</sub>	0.0152	0.0089	
81.1	Cyclohexane	C <sub>6</sub> H <sub>12</sub>	0.0125	0.0073	
101.1	Methylcyclohexane	C <sub>7</sub> H <sub>14</sub>	0.0315	0.0215	
	<b>AROMATICS</b>				
80.0	Benzene	C <sub>6</sub> H <sub>6</sub>	0.0020	0.0011	
110.6	Toluene	C <sub>7</sub> H <sub>8</sub>	0.0082	0.0053	
136.1 - 138.9	Ethylbenzene & p,m-Xyle	C <sub>8</sub> H <sub>10</sub>	0.0092	0.0068	
144.4	o-Xylene	C <sub>8</sub> H <sub>10</sub>	0.0072	0.0053	
168.9	1, 2, 4-Trimethylbenzene	C <sub>9</sub> H <sub>12</sub>	0.0131	0.0109	
<b>Total</b>			<b>1.0000</b>	<b>1.0000</b>	



Note: Physical properties are calculated based on GPA 2145-00 physical constants

GC ID: B140985

**TABLE F7  
ENCANA CORPORATION  
WELL ECA HZ WAHIGAN 04-12-064-23W5 – SAMPLE W3A9234  
RESERVOIR FLUID STUDY  
COMPOSITIONAL ANALYSIS OF FLASHED GAS**

Component Name	Chemical Symbol	Mole Fraction		Liquid Volume	
		As Analyzed	Acid Gas Free	STB/MMscf	mL/m3
Nitrogen	N <sub>2</sub>	0.0020	0.0020		
Carbon Dioxide	CO <sub>2</sub>	0.0048	0.0000		
Hydrogen Sulphide	H <sub>2</sub> S	0.0000	0.0000		
Methane	C <sub>1</sub>	0.3198	0.3214		
Ethane	C <sub>2</sub>	0.2582	0.2595		
Propane	C <sub>3</sub>	0.2457	0.2469	160.427	900.719
i-Butane	i-C <sub>4</sub>	0.0404	0.0405	31.315	175.820
n-Butane	n-C <sub>4</sub>	0.0850	0.0854	63.564	356.878
i-Pentane	i-C <sub>5</sub>	0.0172	0.0173	14.932	83.837
n-Pentane	n-C <sub>5</sub>	0.0160	0.0161	13.775	77.338
Hexanes	C <sub>6</sub>	0.0076	0.0076	7.429	41.711
Heptanes	C <sub>7</sub>	0.0031	0.0031	3.421	19.205
Octanes	C <sub>8</sub>	0.0001	0.0001	0.165	0.924
Nonanes	C <sub>9</sub>	0.0000	0.0000	0.031	0.171
Decanes	C <sub>10</sub>	0.0000	0.0000	0.009	0.049
Undecane	C <sub>11</sub>	0.0000	0.0000	0.000	0.000
Dodecanes Plus	C <sub>12+</sub>	0.0000	0.0000	0.000	0.000
<b>Total</b>		<b>1.0000</b>	<b>1.0000</b>	<b>295.066</b>	<b>1656.652</b>
Propanes Plus	C <sub>3+</sub>	0.4151	0.4171	295.066	1656.652
Butanes Plus	C <sub>4+</sub>	0.1694	0.1702	134.639	755.933
Pentanes Plus	C <sub>5+</sub>	0.0441	0.0443	39.760	223.234

Calculated Gas Properties @ Standard Conditions			Calculated Pseudocritical Properties		
Molecular Weight	34.65 kg/kmol	34.65 lb/lb-mol	Ppc	642.9 psia	4.43 MPa
Specific Gravity	1.1964 (Air = 1)	1.1964 (Air = 1)	Tpc	550.9 R	306.1 K
MW of C7+	96.70 kg/kmol	96.70 lb/lbmol	Ppc*	641.8 psia	4.43 MPa
Density of C7+	0.7233 g/cc	723.3 kg/m3	Tpc*	550.0 R	305.5 K

Calculated Gross Heating Value @ Standard Conditions			Calculated Net Heating Value @ Standard Conditions		
Dry	1,994.1 Btu/scf	74.43 MJ/m3	Dry	1,827.8 Btu/scf	68.23 MJ/m3
Wet	1,959.4 Btu/scf	73.14 MJ/m3	Wet	1,796.0 Btu/scf	67.04 MJ/m3

\* - Corrected for Acid Gas Content

Standard Conditions: 60 F (288.7 K) @ 14.696 psia (0.101325 MPa)

GC ID: A141452

## **Appendix G**

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### **WFT-OILSYSTEM CHARACTERIZATION PROTOCOL**



# Oil Characterization Protocol

